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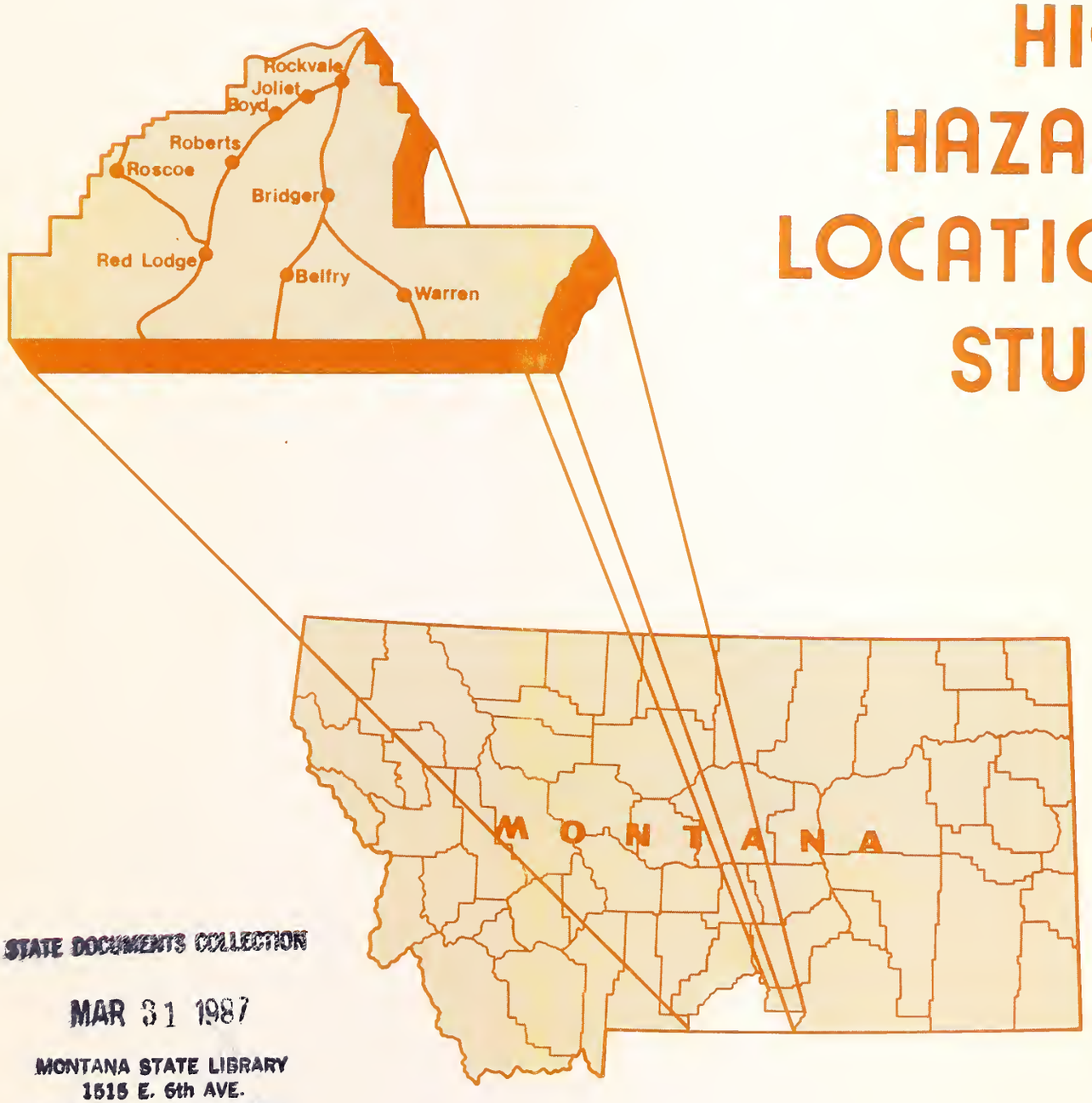

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CARBON COUNTY HIGH HAZARD LOCATION STUDY

Prepared For:

Carbon County, Montana

In Cooperation With:

State of Montana Department of Justice

Highway Traffic Safety Division

and

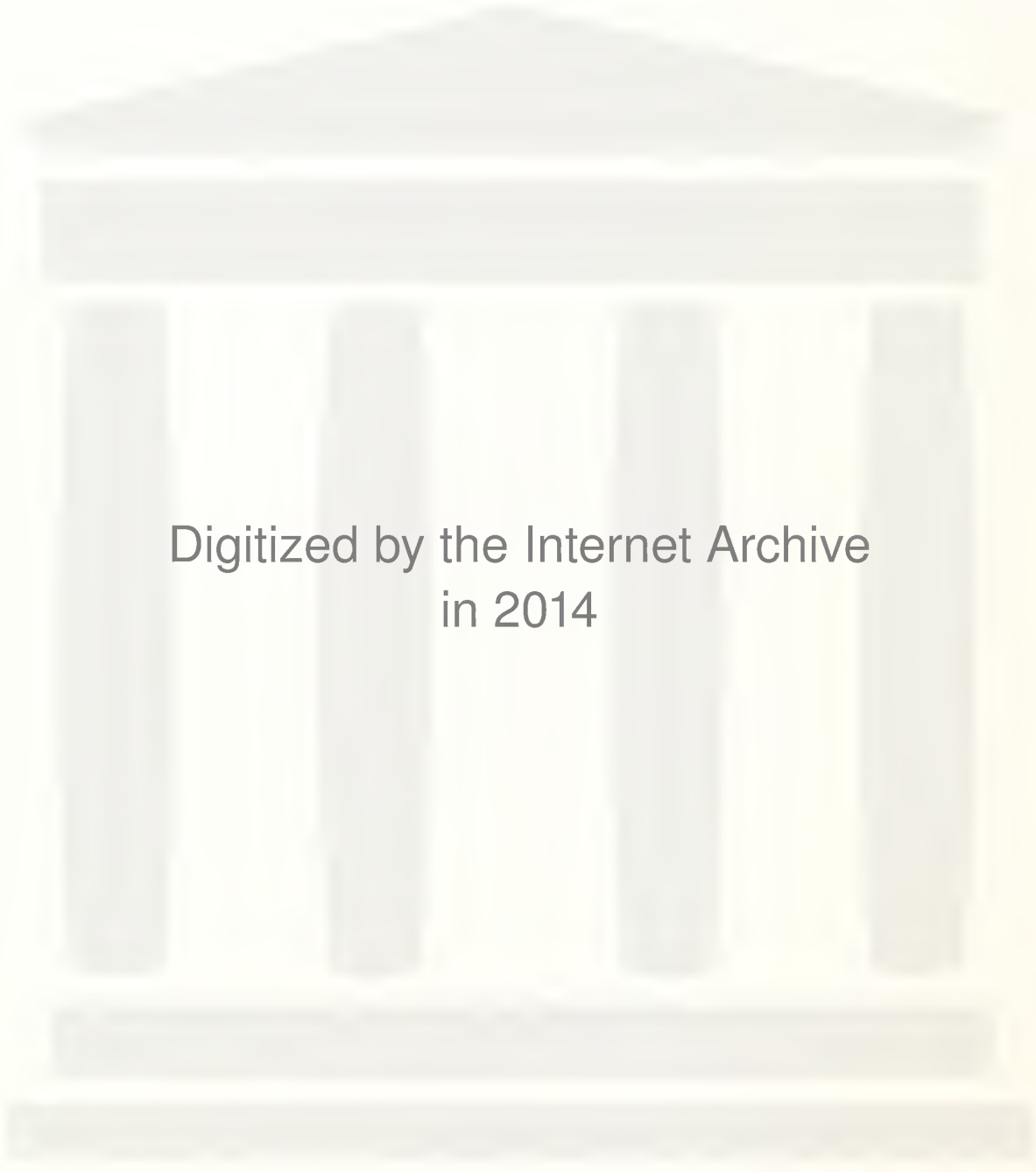
the Montana Association of Counties

Prepared By:

Robert Peccia & Associates, Inc.

Helena, Montana

January, 1983



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February 25, 1983

Board of County Commissioners
Carbon County
Red Lodge, Montana 59068

Transmitted herewith is the final report for the Carbon County High Hazard Location Study. This report documents the results of the traffic studies and surveys performed in the evaluation of ten locations in Carbon County.

Included in this report are: 1) a thorough assessment of the existing conditions at each site; 2) an accident analysis of all reported accidents at each site during the four-year period from January, 1978 through December, 1981; 3) a short-term, low-cost improvement program complete with a prioritized project list based on the relative hazardousness of each site; and 4) a series of long-term, more expensive solutions, generally involving road reconstruction.

It has been a pleasure working with you, and we appreciate your guidance throughout the project. We hope you are satisfied with this report and find it useful in reducing traffic hazards in Carbon County. If you have any questions or are in need of additional information, please don't hesitate to contact us.

Respectfully submitted,

ROBERT PECCIA & ASSOCIATES

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Robert J. Peccia, President

Douglas E. Widmayer

Douglas Widmayer, Project Engineer

DW/gp

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Figure B Existing Conditions
Figure C Composite Collision Diagram
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PHOTOGRAPHS

Photo plates are included for each site in their appropriate sections.

CHAPTER I
INTRODUCTION

CHAPTER I

INTRODUCTION

The purpose of this report is to evaluate ten hazardous road locations in Carbon County and to recommend appropriate improvements. The sites were chosen by Carbon County with the assistance of the Department of Justice, Highway Traffic Safety Division, based on accident history and roadway characteristics. The sites are referenced in Table 1 below and shown on a location map, Figure I-1.

The analysis contained within this report is based on procedures outlined in Report No. FHWA-RD-77-83, Identification of Hazardous Locations, as refined by DCA Project No. 79-04-01-01, Preliminary Evaluation Program for High Hazard Location Study, Yellowstone County, Montana.

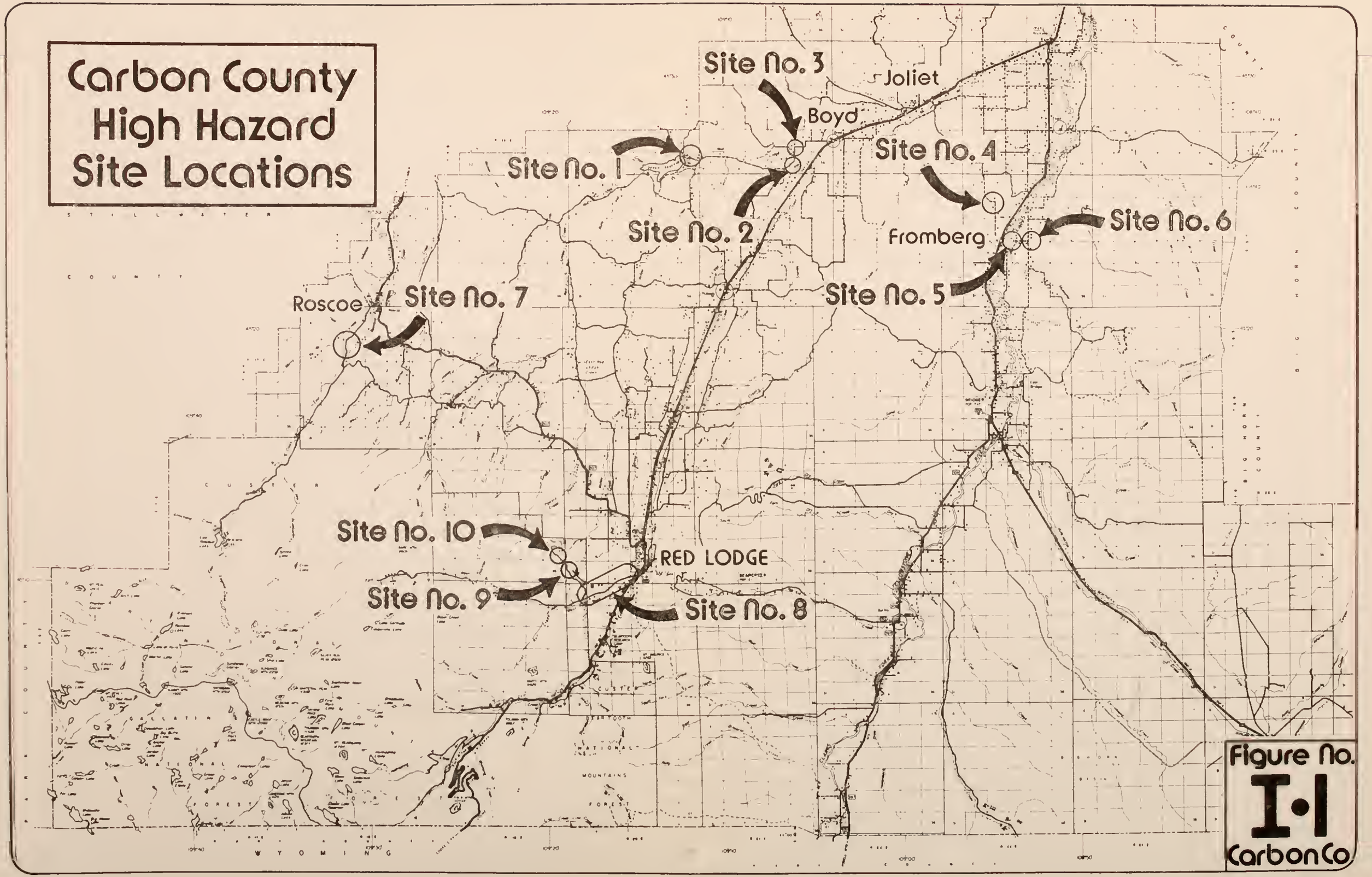
Short-term and in some cases long-term improvements that would reduce or eliminate hazardous conditions have been included for each site. Emphasis was given to relatively low-cost improvements in an effort to present solutions within the funding capabilities of the County. A priority ranking of site improvement projects was developed based on a composite hazard ranking and benefit/cost ratios.

TABLE NO. 1

LIST OF SITES

Site #1:	Red Lodge Creek Bridge at Cooney Dam
Site #2:	Cooney Dam Road (2.5 miles west of Boyd)
Site #3:	Cooney Dam Road (1.9 miles west of Boyd)
Site #4:	Joliet - Fromberg Road
Site #5:	Clarks Fork Bridge east of Fromberg
Site #6:	"T" Intersection east of Fromberg
Site #7:	East Rosebud River Road
Site #8:	West Fork Road
Site #9:	Lower Red Lodge Mountain Road
Site #10:	Upper Red Lodge Mountain Road

Carbon County High Hazard Site Locations



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CHAPTER II
SUMMARY & RECOMMENDATIONS

CHAPTER II

SUMMARY AND RECOMMENDATIONS

A. Summary

The purpose of this study is to identify the factors contributing to unsafe traffic conditions at ten hazardous locations selected by Carbon County, and to recommend improvements that would remedy the unsafe conditions. At each location, a field inspection was made, the site geometrics were recorded, site condition sketches were made, and manual and machine traffic counts were taken. In addition, the accident records for the last four years were obtained from the Department of Justice and analyzed.

Solutions to the problems that were identified included short-term low-cost traffic management-type improvements, and long-term more permanent solutions generally involving road reconstruction and higher costs. These recommended improvement costs are summarized in Table 2.

The ten hazardous sites selected by Carbon County had 44 accidents reported during the four-year period from 1978 through 1981. These accidents included 1 fatality, 20 injury and 22 property damage accidents. The annual cost of these accidents, according to National Safety Council figures, is $75,785. Based on the average accident reduction figures established by the Department of Highways, the short-term improvements recommended in this report could eliminate 50 percent of these accidents.

B. Short-Term Improvements

The short-term improvements recommended for each site concentrate on supplying better guidance to the motorist through conventional signing and striping methods and on improving sight distance within existing right-of-way limits. In general, the short-term improvements for each site cost less than $1,700. The total cost of all short-term improvements is $16,130, based on current construction costs.

C. Long-Term Improvements

Long-term improvements were recommended where deficiencies at a site could not be completely corrected by short-term, low-cost improvements. The long-term improvements generally consist of minor road reconstruction. Due to the nature and the time frame involved with these long-term improvements, it is recommended that they be implemented as funds become available. The total cost of all the long-term improvements is $52,480, based on 1982 construction costs.

TABLE NO. 2

SHORT- & LONG-TERM IMPROVEMENT COSTS

Site No.	Site Name	Short-Term Improvement Cost	Long-Term Improvement Cost
1.	Red Lodge Creek Bridge	$1,647	$ 5,080
2.	Cooney Dam Road (2.5 miles west of Boyd)	1,530	9,000
3.	Cooney Dam Road (1.9 miles west of Boyd)	1,226	5,000
4.	Joliet-Fromberg Road	1,686	*
5.	Clarks Fork Bridge	685	3,500
6.	"T" Intersection east of Fromberg	1,158	*
7.	East Rosebud River Road	1,028	12,000
8.	West Fork Road	3,730	*
9.	Lower Red Lodge Mountain Road	1,260	12,500
10.	Upper Red Lodge Mountain Road	2,180	5,400
Total Cost:		$16,130	$52,480

* At Sites 4, 6 and 8, the short-term improvements adequately addressed the problems; therefore, no long-term improvements have been recommended.

D. Prioritization

To aid the County in deciding the order of implementation for the short-term improvements, a Priority Ranking has been provided. This ranking evaluates the relative hazardousness of each site and the cost of the short-term improvements.

To evaluate the relative hazardousness of each site, a Hazard Index was calculated. This Hazard Index is based on three accident indicators (number of accidents, accident severity, and accident rate) and four "non-accident" indicators (volume/capacity ratio, sight distance ratio, driver expectancy, and information system deficiency). Each site has been ranked according to the accident and non-accident indicators, and the Hazard Index is shown in Table 3.

To determine the proper order of implementation for the short-term improvements, the cost of the improvement must be evaluated with respect to the average traffic volume and the site's Hazard Index. Cost factors and benefit/cost ratios were calculated for each site improvement, and are shown in Table 4.

A Priority Index, which is a weighted average of the Hazard Index and the Cost Factor, was computed for each site. The Priority Index ranking is the recommended order of implementation and should be used as the major consideration in selecting the order of funding for these sites. Due to possible funding limitations, it may be advantageous to skip one or two improvement projects in order to implement a greater number of improvements. The Priority Index ranking of the short-term improvements is shown in Table 5.

No prioritization has been offered for the long-term improvements due to the costs involved. It is recommended that the long-term improvements be implemented as funds and/or right-of-way become available.

E. Implementation

The short-term improvements recommended in this report address the major problems at each site. After evaluating the availability of funds, Carbon County should schedule the implementation of the short-term improvement projects according to the priority listing shown in Table 5. Due to the relatively low cost of these improvements, it is believed that implementation could be scheduled over a two- to three-year period without becoming a financial burden on the County. It is recommended to complete the short-term improvement program prior to funding any of the long-term improvements.

All long-term improvements are considered of equal importance and should be implemented as funds become available.

Throughout this report, when warning signs are recommended, the 30" x 30" size sign is to be used. Likewise, all advisory speed plates should be of the 18" x 18" size. The placement of all signs, delineators, guard rails, and pavement markings should always be in conformance with the Manual on Uniform Traffic Control Devices. Speed limits should be set as outlined in Section 61-8-310 of the Montana Motor Vehicle Code.

TABLE NO. 3

HAZARD INDEX RANKING

Ranking	Site No.	"Accident" Indicators
1	8	43.88
2	10	41.66
3	1	41.28
4	3	41.09
5	2	40.60
6	9	39.18
7	4	37.00
8	7	36.69
9	5	32.86
10	6	29.78

Ranking	Site No.	"Non-Accident" Indicators
1	7	31.48
2	2	29.51
3	10	28.75
4	4	25.97
5	9	24.22
6	1	22.56
7	8	22.40
8	3	20.59
9	5	20.02
10	6	16.58

Ranking	Site No.	Hazard Index
1	10	70.41
2	2	70.11
3	7	68.17
4	8	66.28
5	1	63.84
6	9	63.40
7	4	62.97
8	3	61.68
9	5	52.88
10	6	46.36

TABLE NO. 4

BENEFIT/COST RANKING

Ranking	Site No.	Short-Term Improvement Cost	Cost Factor Indicator	Benefit/Cost Ratio
1	8	3,730	88	6.7
2	3	1,226	89	5.1
3	9	1,260	94	4.2
4	10	2,180	88	4.2
5	4	1,686	88	3.3
6	1	1,647	82	3.1
7	2	1,530	86	2.2
8	7	1,028	82	1.8
9	5	685	96	1.3
10	6	1,158	92	0.4

TABLE NO. 5

PRIORITY RANKING OF SHORT-TERM IMPROVEMENTS

Priority Ranking	Site No.	Site Name	Short-Term Improvement Cost	Priority Index
1	10	Upper Red Lodge Mountain Road	$2,180	74.81
2	2	Cooney Dam Road (2.5 miles west of Boyd)	1,530	74.08
3	8	West Fork Road	3,730	71.71
4	7	East Rosebud River Road	1,028	71.63
5	9	Lower Red Lodge Mountain Road	1,260	71.05
6	4	Joliet-Fromberg Road	1,686	69.23
7	3	Cooney Dam Road (1.9 miles west of Boyd)	1,226	68.51
8	1	Red Lodge Creek Bridge at Cooney Dam	1,647	63.68
9	5	Clarks Fork Bridge	685	63.66
10	6	"T" Intersection East of Fromberg	1,158	57.77

CHAPTER III
PROCEDURE & METHODOLOGY

CHAPTER III

PROCEDURE AND METHODOLOGY

A. Field Investigation and Data Collection:

The conclusions and recommendations contained in this report are the product of an extensive data gathering procedure undertaken for each high hazard location. It is impossible to obtain a realistic view of conditions at a particular site without firsthand experience at the site. The background data collected during initial research and on-site visits revealed the circumstances that make one particular location more hazardous than another. The data gathering procedure used during this study included (in chronological order): 1) initial accident research; 2) initial site visit and site identification; 3) site survey; 4) site photography; 5) detailed site sketch; 6) traffic counts; 7) on-site accident analysis; 8) ball bank testing; 9) sight distance determination; 10) subjective rating of site drivability and physical layout; and 11) observation of driver characteristics and quality of travel. The following section contains a brief explanation of each activity undertaken by two field technicians during the data collection stage of this project.

1. Initial Accident Research

The Montana Department of Justice, Highway Traffic Safety Division initially identified accident clusters for individual counties from historical accident reports and accident location plot maps. The accidents within a particular area were then summarized in a list and submitted to Robert Peccia & Associates. All accidents listed were then retrieved and copied from microfilmed records of accident reports. The accident reports were grouped by general location and listed in chronological order. Accidents that occurred during the study period (January, 1978 to December, 1981) were used for further analysis. Those accidents that occurred before or after the study period were retained for reference.

2. Initial Site Visit and Site Identification

The initial visit to each cluster area was made with a representative of each county, if possible, and a representative of the Montana Department of Justice. At this time, the specific high hazard location was identified through the analysis of each group of accident reports and through the input of the local representative. The firsthand knowledge of the long-term accident history and traffic characteristics at each site thus obtained was extremely beneficial.

3. Site Survey

Field technicians utilized survey equipment to identify the physical layout of the roadway itself. Data gathered during the site survey included av-

erage road grades within the site, roadway alignment, superelevation in curves, roadway widths, and identification of right-of-way widths.

4. Site Photography

During site visits, many photographs were taken to illustrate site characteristics or to identify deficiencies within the site. These photographs were utilized in many ways during the preparation of the report and the report graphics. Aerial photography at the largest scale possible was obtained and used during base map preparation and site analysis. In most instances, the combination of aerial photography and extensive "on the ground" photography minimized the need for return visits to the sites.

5. Site Sketch

Sites were stationed at 100-foot intervals and the locations of significant features were mapped. This phase of the data collection involved extensive field measurements of site details including site locations, pavement marking changes, roadside delineators, utilities adjacent to the roadway, fencing, and roadside vegetation. Site photography was also extensively utilized to produce accurate sketches.

6. Traffic Counts

Available traffic count data was obtained from the Planning and Research Bureau of the Montana Department of Highways and used for as many sites as possible. For those sites lacking such information, 24-hour recording traffic counters set to record traffic volumes in 15-minute intervals were set at the required locations. If the site included a major intersection and traffic was significant, peak hour turning movements were conducted in addition to 24-hour traffic counts. This traffic data was used to determine the average daily traffic (ADT) and for capacity analysis. Traffic counts conducted by Robert Peccia & Associates were submitted to the Department of Highways to augment their traffic count data.

7. Accident Analysis

All reported accidents for each specific site location that occurred during the study period of 1/78 through 12/81 were plotted on collision diagrams. Accident data for the study period was also summarized and used in the field. These summaries allowed the field technicians to reconstruct the accidents and to better understand the circumstances that made for unsafe driving conditions at a particular site. The number of accidents and traffic volumes were used to compare accident rates of specific sites.

It should be noted that alcohol-related accidents have been categorized in two ways on the accident data summary sheet contained in each site analysis. In the first instance, alcohol was listed as a possible violation by the driver of the vehicle (i.e., driving while intoxicated.) In this item, alcohol was treated in the same manner as reckless driving, speeding, and other driving violations. In addition, an accident tally was completed that summarized the number of times drinking was listed as a possible violation and identified the number of accidents that had some form of alcohol involvement by the driver or passengers.

8. Ball Bank Testing

The vehicle utilized during field data collection was equipped with a ball bank indicator or safe curve speed indicator. The instrument provides a simple way to establish the safe advisable speed necessary to comfortably pass through a curve where no speed restrictions exist. The posted advisory speeds on curves were also verified through the use of this instrument. Only those sites with unrestricted traffic flows were tested.

9. Stopping Sight Distance Determination

Sight distance is a major element in the safe and efficient operation of any roadway. Stopping sight distance, the minimum distance needed for a vehicle travelling near or at the design speed for the roadway to stop for an object in its path, was measured by two field technicians. Actual sight distance limitations were measured using an eye height of 3.75 feet and an object height of 0.5 feet. Vehicle speed, roadway surface conditions, obstructions, and driver characteristics were also considered in sight distance measurement. The measurement of sight distance at intersections required the development of a minimum sight triangle, which considers unobstructed sight distance along both roads at an intersection and across the included corner.

10. Subjective Rating of Site Drivability and Physical Layout

After the field data was gathered for each site, two field technicians independently rated the drivability of the site and the completeness of the information system presented to motorists entering the site. The rating was completed on the Driver Expectancy and Information System Deficiencies forms, which are discussed in the following section of this chapter. These ratings present a relatively unbiased impression of the site layout and characteristics, since they were arrived at independently by technicians who were not familiar with the site prior to the data collection phase of the project.

11. Observation of Driver Characteristics and Quality of Travel

During the collection of field data, time was taken to observe motorists' driving habits through each site. Field observations of drivers were completed both during day and nighttime light conditions to obtain an overall impression of driver tendencies and to detect deficiencies in the overall layout of the site.

B. Analysis of Data and Calculation of Hazard Indices:

A hazard index was calculated for each site based on the following seven indicator values:

1. Number of Accidents
2. Accident Rate
3. Accident Severity
4. Volume/Capacity Ratio
5. Sight Distance
6. Driver Expectancy
7. Information System Deficiencies

For each indicator, a value between 0 and 100 was calculated, with 0 representing no hazard and 100 representing the most hazardous. The indicator values were then weighted and totalled according to accepted Department of Justice methods and values outlined in DCA Project No. 79-04-01-01 to yield the Hazard Index.

The improvement costs for each site were calculated using current construction costs and weighted against the accident reduction benefits associated with the type of improvement. In addition to the cost/benefit ratio, a cost factor was determined. The cost factor represents the improvement costs per vehicle computed by dividing the total cost for improvements at a site by the number of vehicles entering that location over a period of five years. A five-year period is used because that is the average service life of the recommended short-term improvements. The form used to compute the cost factor is shown in Figure A2 in the Appendix.

The final phase in the analysis was to determine the Priority Index (P.I.). The Priority Index is the weighted average of the Hazard Index (H.I.) and the Cost Factor (C.F.), as shown in the following equation:

$$P.I. = 0.75\ (H.I.) + 0.25\ (C.F.)$$

The site improvements were then ranked according to priority based on the Accident Hazard Indicators, Non-Accident Hazard Indicators, Cost/Benefit Ratios, Hazard Index, and Priority Index.

The following section contains a brief explanation of each of the Hazard Indicators and the Cost/Benefit Ratio.

1. Number of Accidents

Accident records for a three-year period from January, 1978 through December, 1981 were obtained from the Montana Highway Patrol. This accident data was then used to determine the three "accident" indicators (number of accidents, accident rate and accident severity). The annual average number of accidents occurring at each site was used to calculate this indicator value. Figure A3 in the Appendix shows the relationship between the annual number of accidents and the indicator value.

2. Accident Rate

This indicator is used to compensate for the wide range of traffic volumes found throughout the study sites. The average daily traffic entering each site was calculated and adjusted to represent a three-year volume. The total number of accidents per million vehicles entering the site was then calculated, resulting in the accident rate. This figure was entered into Figure A4 in the Appendix to yield the corresponding indicator value.

3. Accident Severity

This indicator evaluates the severity of the accidents occurring at each site in terms of dollars. A "Relative Severity Index" (Table A1 of the Appendix) was used to rate each accident according to accident type and to assign a corresponding accident cost. The R.S.I. values used are those in-

cluded in DCA Project No. 79-04-01-01. The average of the R.S.I. values at each site was calculated and entered into Figure A5 in the Appendix to determine the appropriate indicator value.

4. Volume-to-Capacity Ratio

The individual characteristics of the sites vary greatly. This indicator value normalizes each site with respect to lane width, geometrics, traffic mix and volume. The capacity of each site was calculated for Service Level C in accordance with the Highway Research Board, Special Report 87, Highway Capacity Manual. The volume used represents the average daily traffic entering the site. The equation used to compute the index is as follows:

$$\frac{V}{C} = \frac{ADT}{24\ (Capacity)}$$

This ratio was entered into Figure A6 (found in the Appendix) to yield the corresponding indicator value.

5. Sight Distance

The sight distance at a particular site is an excellent indicator of the hazardousness of that location. Critical sight distances were measured at each location based on the criteria outlined in the DCA Project No. 79-04-01-01. The desirable sight distances for each particular location were then calculated according to the AASHO Manual Geometric Design of Rural Highways. For each case, the ratio of the existing versus the desirable Sight Distance was calculated. The two worst cases at each site were evaluated and a weighted average was computed by assigning a weight of two to the worst rating and one to the other rating. This weighted average sight distance ratio entered into Figure A7 (found in the Appendix) yields the corresponding indicator value.

6. Driver Expectancy

The driver expectancy indicator is a purely subjective method of evaluating the ability of the average motorist to negotiate a particular section of roadway or intersection. Each site approach was rated using the criteria included on the driver expectancy form shown on Figure A8 in the Appendix. Each site was evaluated individually by two technicians and the ratings were averaged. The two approaches with the worst ratings were used in the calculation of the indicator value. A weighted average of the two ratings was calculated according to DCA weighting methods and used in Figure A9 of the Appendix to compute the corresponding indicator value.

7. Information System Deficiencies

Similar to the driver expectancy ratings, this indicator is based on the subjective judgment of the evaluator. This rating consists of evaluating the signing and striping systems at each site with respect to the systems' ability to inform and guide the motorist through a particular section of road or in-

tersection. The actual criteria used in this evaluation are shown on the rating form (Figure A10) found in the Appendix.

All site approaches were independently rated by two technicians and their ratings averaged. Only the two worst average approach ratings were actually used to calculate this indicator. A weighted average of the two ratings was computed according to the weighting formula outlined in DCA Project 79-04-01-01. This weighted average was entered into Figure A11 in the Appendix to yield the appropriate indicator value.

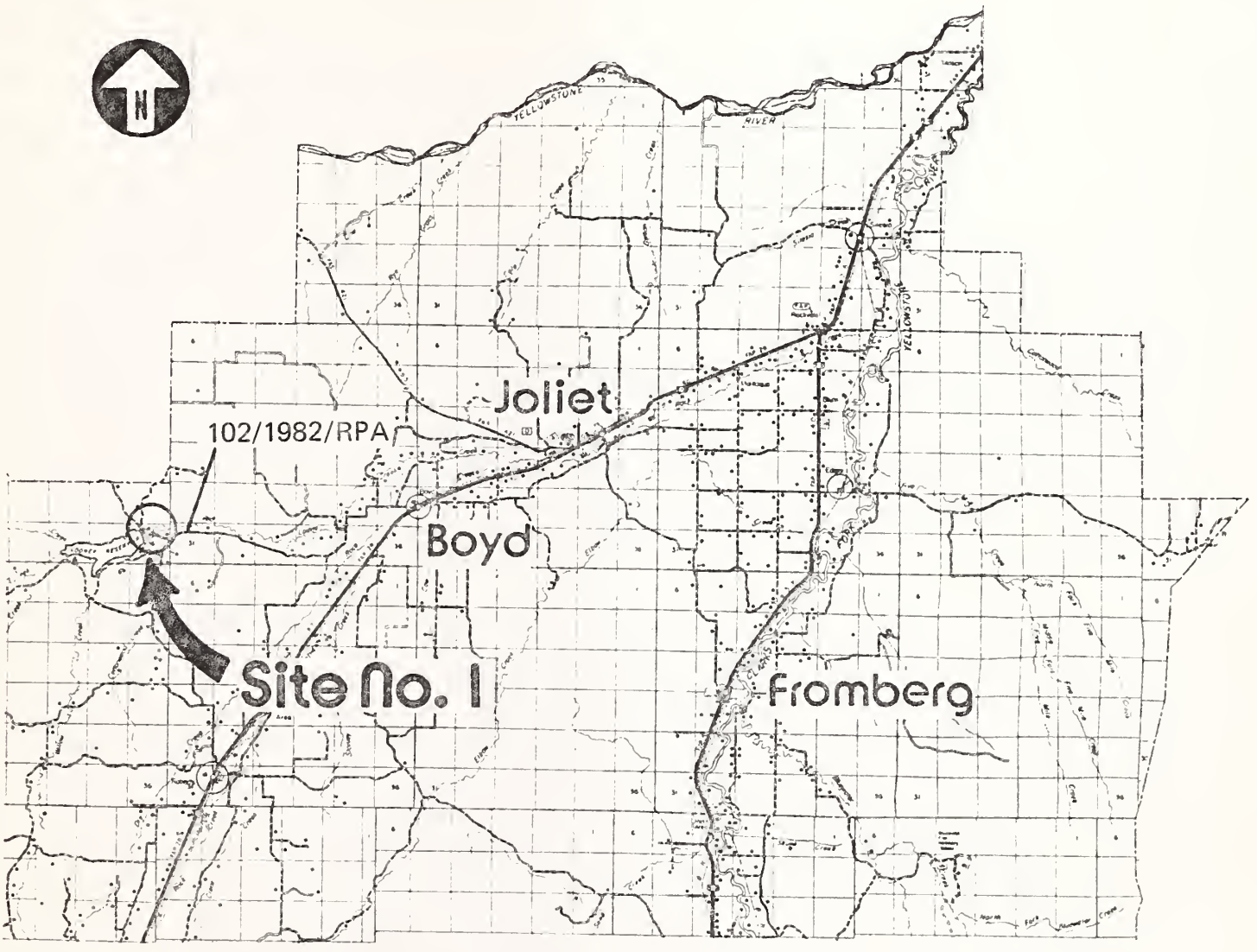
8. Benefit/Cost Ratio

Each site was analyzed and improvements were recommended. The improvement costs were estimated based on current Department of Highways statewide average construction costs. Although it is likely that Carbon County will implement some of the improvements with County forces, the "contracted" construction costs were used throughout for comparison purposes.

The benefits of each improvement were calculated based on the anticipated accident reduction resulting from that particular improvement. The Montana Department of Highways method for calculating the benefit/cost ratio was used and the computation format is shown in Figure A12 of the Appendix. A ranking of each site based on the benefit/cost ratio was compiled and is presented in Table 4. The site improvement yielding the greatest accident reduction benefit per dollar spent was given the highest ranking.

CHAPTER IV
SITE ANALYSIS

SITE 1



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
RED LODGE CREEK BRIDGE

Figure No.
I-A
Carbon Co

SITE #1

RED LODGE CREEK BRIDGE AT COONEY RESERVOIR

A. Location

Site #1 is located approximately 7.5 miles west of Boyd at the Cooney Reservoir. The site includes the bridge over Red Lodge Creek and both its approaches. Site #1 is located in the gently rolling terrain adjacent to Red Lodge Creek in the northwestern portion of Carbon County. Land in this portion of the county is predominantly used as pasture land for livestock or for the production of feed crops. In addition to serving local traffic, the roadway provides the major access route for visitors utilizing the recreational facilities at the Cooney Reservoir State Recreation Area. The location and traffic count data for this site are presented in Figure 1A.

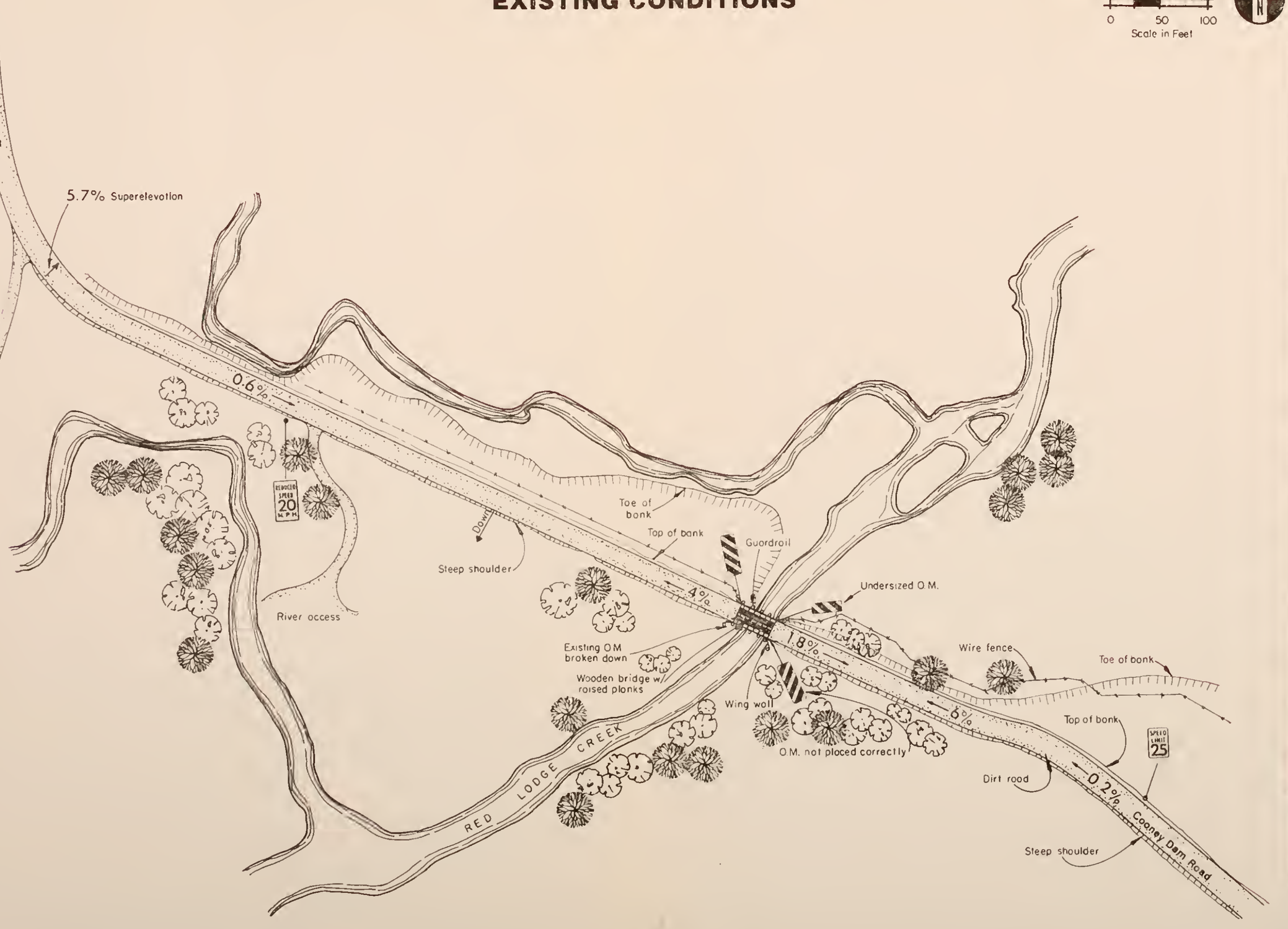
B. Existing Conditions

Both approaches to the Red Lodge Creek Bridge at Cooney Reservoir are gravel-surfaced roadways varying in width from 18 to 22 feet. Road grades at the site change considerably, since the bridge itself is considerably higher than either approach to it. Grades at the bridge slope at approximately 4 percent from the bridge on the east approach and from 1.8 to 6 percent on the west approach to the bridge. The curve located on the east approach has an effective superelevation of 5.7 percent. Signing consists of a 25 mph speed limit sign (R2-1) located 420 feet from the end of the bridge on the east approach and a "Reduced Speed - 20 mph" sign (R2-5b) located 500 feet from the bridge on the west approach.

The Red Lodge Creek Bridge is a wooden structure 36 feet long and 16.5 feet wide. The wooden deck of the structure is reinforced with a raised wood plank driving lane. The structure is equipped with a metal guard rail; however, neither end of the bridge has an approach railing. The Montana Department of Highways Bridge Evaluation Bureau conducted a structural inventory of the bridge in June, 1981. The report indicated that the bridge was in need of structural repair to bridge piles and one of the wingwalls. The remainder of the bridge components were in generally good condition. The report also stated that the object markers on the east end of the bridge should be replaced. The existing left marker is intended for use on the right side of the bridge and the existing right marker is not standard sized. This condition was unchanged at the time of the field inspection. In addition, the right marker has been damaged and is presently ineffective. The existing conditions at Site #1 are depicted in Figure 1B and in Plate 1.

Based on machine counts of 24-hour traffic volumes conducted during October, 1982 by Robert Peccia & Associates, average daily traffic (ADT) was determined to be 102 vehicles. It is anticipated that traffic volumes may be substantially higher during the summer months due to the recreational traffic generated by the Cooney Reservoir State Recreation Area.

EXISTING CONDITIONS



RED LODGE CREEK BRIDGE
AT COONEY DAM

Site No. I

Figure No.
I-B
Carbon Co

Existing Site Conditions

East approach to the Red Lodge Creek Bridge near Cooney Reservoir.

View of west approach to the bridge.

Abrupt change in grade on the east approach limits sight distance to approximately 155 feet at this location.

View of the Red Lodge Creek Bridge. Note the missing object marker to the right and the lack of approach railing.

Plate 1

C. Accident History

A total of four accidents were reported at Site #1 over the four-year accident study period. Two of the four accidents resulted in injuries to a total of three persons. All four accidents occurred during the day and under clear weather and dry road conditions. Two of the accidents involved more than one vehicle, and occurred on the approaches to the bridge. One accident involved a loss of control by the driver, who subsequently hit the bridge and overturned into Red Lodge Creek. It appears that excessive speed for road conditions at this site was a major contributing factor to the accidents that occurred, but alcohol was also involved in two of the four reported accidents. All of the accidents occurred on weekends during the summer months, and three of the four accidents involved out-of-county drivers who were going to or leaving the recreation area. The composite collision diagram for Site #1 is depicted in Figure 1C.

The accident rate at this site is 26.9 accidents per million vehicles entering.

D. Recommendations

Site #1 contains several potential hazards. The existing signing of the single-lane bridge is inadequate and misleading, and the curve in the road west of the bridge is not signed or delineated. The short-term improvements listed below concentrate on upgrading the signing at this site, while the long-term improvements address the sight distance limitations and the guard rail protection at the bridge.

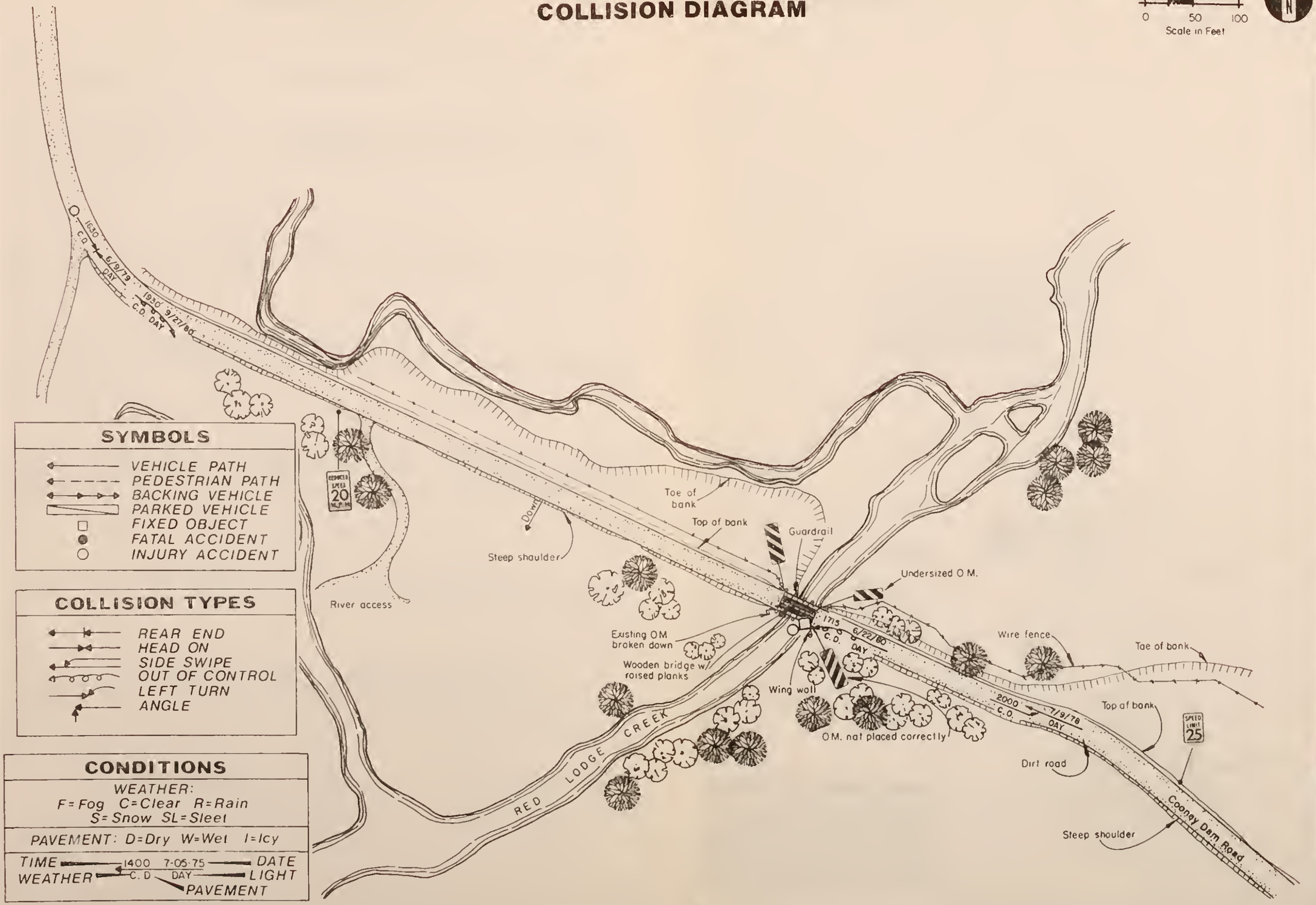
1. This bridge should be properly identified. At present, the object marker on the northeast corner is undersized, the marker on the southeast corner is slanting the wrong way, and the southwest corner is not identified because the object marker is damaged. All object markers used to delineate bridge ends should be Type 3 markers (OM-3), and should be 12" by 36" in size. In addition, the crosshatching should always slant downwards at a 45-degree angle toward the travel lane. It is recommended that the undersized marker on the northeast corner of this bridge be removed. The existing marker on the southeast bridge corner should be relocated to the southwest corner where it will present the proper guidance to motorists. New object markers (OM-3, 12" x 36") should be installed on both sides on the bridge on the east approach.

2. In addition to the proper delineation of the bridge, signing should alert motorists that the bridge is a one-lane structure. For this reason, one-lane bridge warning signs (W5-3) should be installed on both approaches. On the west approach, the warning sign should be located 500 feet back, and on the east approach it should be located 350 feet from the bridge. This setback distance will place the warning sign at the crest of the hill where motorists can first see the bridge, but where it will still be located far enough back to allow adequate time to react to the situation.

COLLISION DIAGRAM

0 50 100
Scale in Feet

N



SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME 1400 7-05-75 DATE
WEATHER C.D DAY LIGHT
PAVEMENT

RED LODGE CREEK BRIDGE AT COONEY DAM

Site No. I

Figure No. I-C

Carbon Co

ACCIDENT DATA

Red Lodge Creek Bridge at Cooney Reservoir

SITE NUMBER 1 ACCIDENT PERIOD 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
1	1	2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2						2

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					2	1		1			

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
															1	1		1	1				

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
4			

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
4				

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
4			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			1			1	1	1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
3			1					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury		1	1	
Fatality				
Property Dam. Only	1		1	

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

2

3. The curve in the road west of the bridge should be identified. According to the accident records, excessive speed was a contributing factor to several accidents at this site. A ball bank indicator was used to determine that 20 mph is the maximum safe speed for this curve. It is therefore recommended that turn warning signs (W1-1) with 20 mph advisory speed plates (W13-1) be installed on both approaches to the curve. In addition to these warning signs, reflectorized delineators should be used to identify the roadway alignment in the curve. A series of nine reflectors (Design C, 4" x 4", silver) should be installed on the outside of the curve. Delineators should be spaced 50 feet apart in the curve, and 100 feet apart on the approaches. In this way, drivers will be safely led into and around the curve. The recommended location of the warning signs and delineators are shown in Figure 1D.

4. The travelway varies from 18 to 22 feet in width throughout the site. The narrow roadway width in the curve west of the bridge is of particular concern, since one head-on collision occurred in this curve. The room necessary for a vehicle to negotiate a curve on a gravel surface is often much greater than that necessary to negotiate adjacent road sections. It is therefore recommended that the roadway surface in this curve be increased to 30 feet. This additional width will provide enough space to allow vehicles to pass safely in the curve.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1	ea	Remove Undersized Object Markers	$35	$ 35
1	ea	Relocate Object Marker (OM-3)	$70	70
2	ea	Install Object Markers (OM-3, 12" x 36")	$130	260
2	ea	Install One-Lane Bridge Signs (W5-3)	$130	260
2	ea	Install Turn Warning Signs (W1-1) with 20 Mph Advisory Speed Plates (W13-1)	$180	360

Quantity	Unit	Item Description	Unit Price	Total Price
9	ea	Install Reflectorized Delineators (Design C, 4" x 4", silver)	$18	$162
-	Lump Sum	Widen Road Surface to 30 ft. in Curve	-	500
Total Cost:				$1,647

Benefit/Cost Ratio: 3.1

Long-Term Improvements

The bridge over Red Lodge Creek was the site of an accident in which a vehicle hit the existing guard rail and plunged into the creek. This bridge should be modified to provide additional protection to motorists by installing four 30-foot-long sections of guard rail. These sections should be attached to the ends of the existing guard rail and extended down the approaches. For more information on installing these guard rail sections, see the Montana Department of Highways Standard Specifications - Standard Drawing #89.

The sight distance at this site is limited to less than 150 feet at several locations on the east approach due to the hill and the steep bridge approach grade. It is recommended that the crest of the hill be cut down approximately two feet so that the vertical curve will be lengthened. To keep snow drifting to a minimum, the shoulders and the adjacent embankments should also be cut down and sloped back. Sight distance will thereby be increased to approximately 300 feet. The excavated material (approximately 800 cy) should be utilized to flatten the grade of the east approach to the bridge.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
120	lf	Install Guard Rail Extensions to Bridge	$9	$1,080
800	cy	Excavation and Embankment, including Road Reconstruction	$5	4,000
Total Cost:				$5,080

RECOMMENDED IMPROVEMENTS

0 50 100
Scale in Feet

N

W1-1L
20 MPH W13-1
Install 500' North of Curve

Install (9) Reflectorized Delineators
Design "C", 4"x4", Silver

Widen Road to 30' in Curve

100'
100'
50'
50'
50'
100'

W1-1R
20 MPH W13-1

Remove

Steep shoulder

W5-3

River access

Reinstall Existing OM-3

Existing O.M. broken down

Wooden bridge w/ raised planks

Toe of bank

Top of bank

Guardrail

RED LODGE CREEK

Wing wall

O.M. not placed correctly

Remove

Undersized O.M.

Install (2) OM-3
(12"x36")

W5-3

Wire fence

Top of bank

Dirt road

SPEED LIMIT 25

400 C.Y.

200 C.Y.

Steep shoulder

Cooney Dam Road

LONG TERM IMPROVEMENT

Cut Down Crest of Hill & Increase Vertical Curve. Excavate 600 C.Y. of Material from Shoulders & Use to Flatten East Bridge Approach

LONG TERM IMPROVEMENT

Install 30' Guardrail Extensions to Existing Rail Both Approaches Both Sides of Roadway

RED LODGE CREEK BRIDGE
AT COONEY DAM

Site No. I

Figure No.
I-D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number *1* Date *December, 1982*

Site Description *Red Lodge Creek Bridge at Cooney Reservoir*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*1.0* acc/yr	*26*	x 0.164 =	*4.26*
Accident Rate	*26.9* acc/MVE	*100*	x 0.225 =	*22.50*
Accident Severity	*15,525* dollars	*76*	x 0.191 =	*14.52*
Volume/Capacity Ratio	*.14*	*32*	x 0.082 =	*2.62*
Sight Distance Ratio	*.73* (wt. avg.)	*60*	x 0.074 =	*4.44*
Driver Expectancy	*3.0* (wt. avg.)	*50*	x 0.149 =	*7.45*
Information System Deficiencies	*4.2* (wt. avg.)	*70*	x 0.115 =	*8.05*

Hazard Index: *63.84*

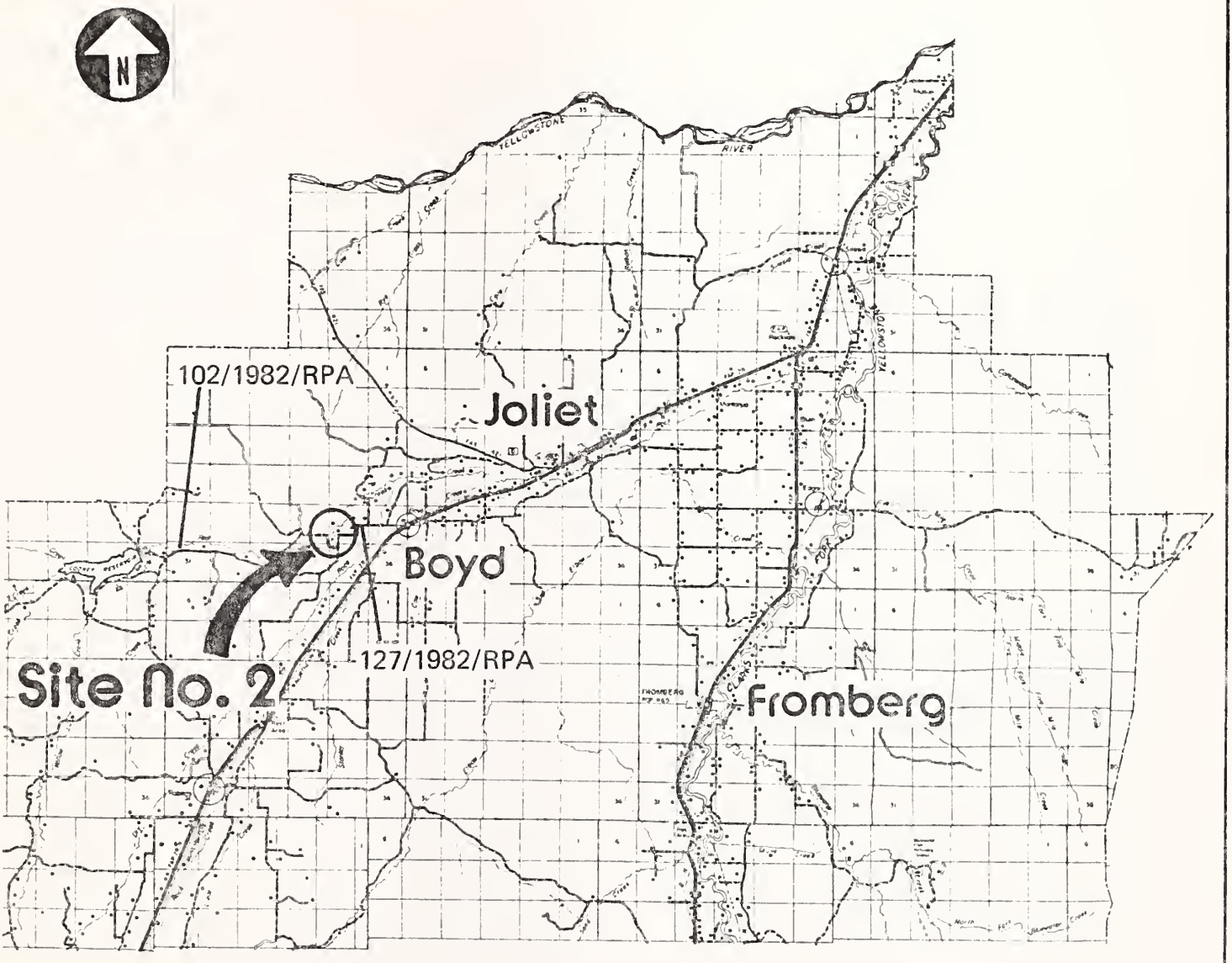
Cost of Recommended Improvements: *$1,647*

Cost Factor: *82*

Priority Index = Hazard Index x .75 + Cost Factor x .25

63.84 x .75 + *82* x .25 = *68.38*

SITE 2



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
COONEY DAM ROAD

Figure No.
2-A
Carbon Co

SITE #2

COONEY DAM ROAD
(2.5 miles west of Boyd)

A. Location

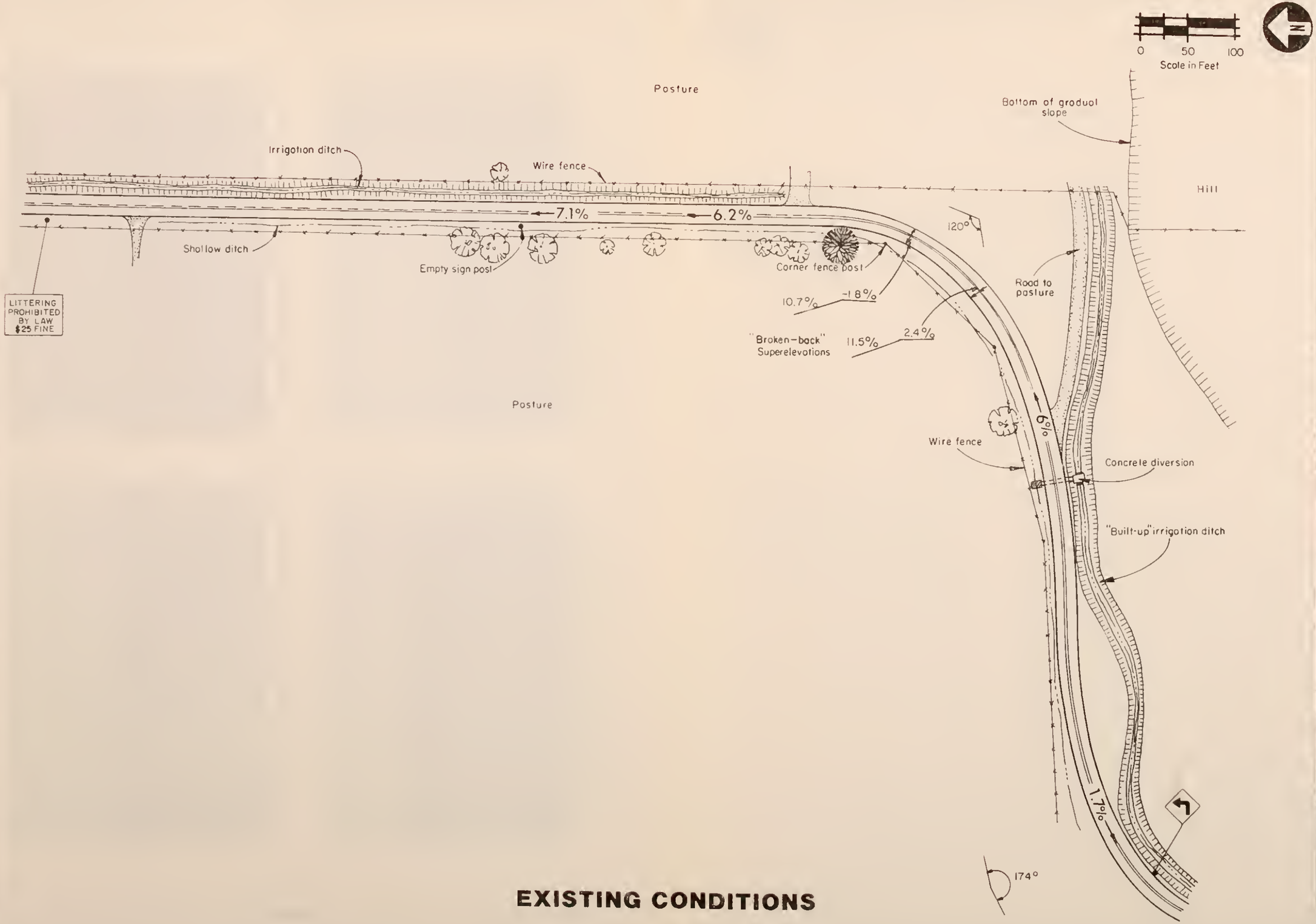
Site #2 is located approximately 2.5 miles west of Boyd in the northwestern portion of Carbon County. The site is situated in a lightly developed rural area in whieh agricultural land is used primarily for pasture or as irrigated cropland. The site consists of a relatively sharp turn in the northwestern portion followed by a sweeping reverse turn. In addition to providing serviee to loeal traffie, the roadway also provides major access to the State Reereation Area loeated at Cooney Reservoir. The loeation of this site and the available traffie eount data are presented in Figure 2A.

B. Existing Conditions

The asphalt pavement surfaee of this site is typieally 22 feet wide and in good condition. Pavement markings delineate two 12-foot driving lanes and 1-foot shoulders. Pavement striping within the site is depicted in Figure 2B. Road grades in the vieinity of the sharp eurve in the northern portion of the site slope toward the north at approximately 6 to 7 percent. Grades in the western portion of the site fall to the west at a uniform grade of 1.5 to 2 pereent. A "broken back" superelevation in the sharp eurve affeets movement through the site. The westbound lane has a superelevation ranging from 10.5 to 11.5 pereent, while the superelevation in the east-bound lane is approximately 2 percent. The direction of travel changes about 120 degrees through the sharp curve. Obstruetions are generally more than six feet from the edge of the roadway, except in the corner. Sight distanee within the sharp eurve at the site is limited to approximately 200 feet due to the eurvature and grade changes at this location. The group of large trees on the north approaeh probably limits sight distanee even more during the summer months.

Signing on the north approaeh eonsists of a "Littering Prohibited" sign. In addition, a post without a sign is loeated approximately 500 feet before the curve on the north approach. It is assumed that this post onee held a turn sign (W1-1R), whieh is missing at present. Signing on the west approaeh to the eurve consists of a turn sign (W1-1L) located 500 feet before the eurve. There are no posted speed limit signs within the site. Existing site eonditions are depicted in Figure 2B and in Plate 2.

Based on maehine counts of 24-hour traffie volumes eollected by Robert Peccia & Associates during November, 1982, the average daily traffie (ADT) for this location was determined to be 127 vehicles. Traffie during the summer should be significantly higher due to increased use of the State Recreation Area.



EXISTING CONDITIONS

COONEY DAM ROAD

Site No. 2

Figure No. 2-B

Carbon Co.

Existing Site Conditions

View of north approach to the site. Note pavement markings and lack of any advance warning signs.

View of west approach to the curve. Note advance turn warning sign but lack of advisory speed information.

View of sharp curve in the middle of Site 2. Ball bank testing indicated that 20 mph is the safe speed for this curve.

Changes in roadway alignment and grade on the west approach limit sight distance to approximately 190 feet.

Plate 2

C. Accident History

A total of five accidents were reported at this location during the study period. One of the accidents resulted in injuries to a total of three persons. All five accidents reported at this site were fixed-object collisions in which the vehicles left the roadway and struck roadside objects. Four of the five accidents occurred during clear weather; two occurred during icy road conditions. In four of the five reported accidents, excess speed was listed at the major contributing factor; alcohol was involved in one of the accidents. The composite collision diagram for this site is depicted in Figure 2C.

The accident rate at this location on the Cooney Dam Road is 27.0 accidents per million vehicles entering.

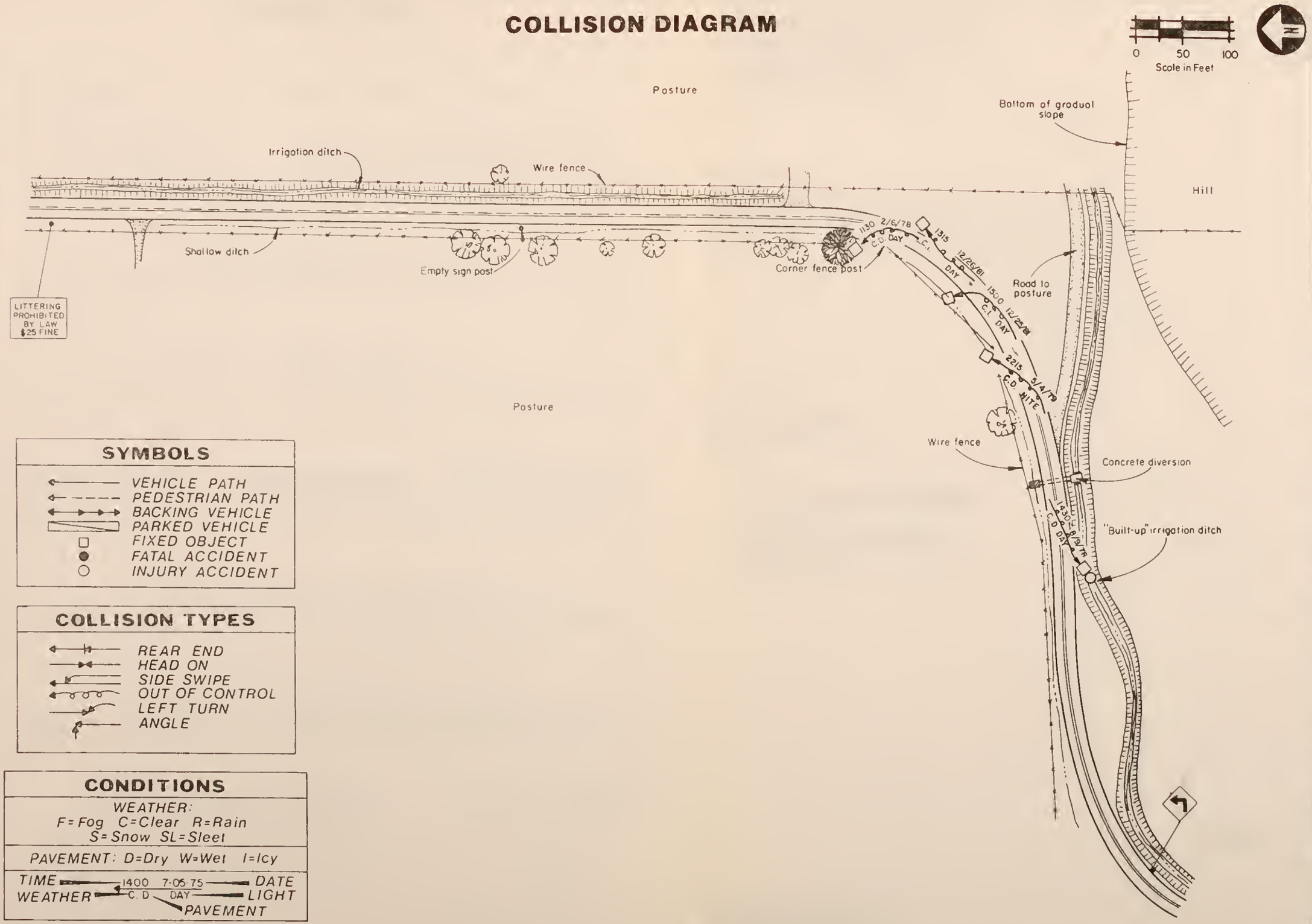
D. Recommendations

According to the accident records, excessive speed is a major cause of accidents in the curve at this site. In addition to inadequate signing and delineation, this curve has a built-in problem in the form of a bad superelevation. The short-term improvements outlined below address the signing deficiencies, while the long-term improvements deal with the necessary road reconstruction at this site.

1. The present signing system at this site consists of one turn warning sign (W1-1) on the west approach. Additional signing is required to properly identify the curve situation at this site. It is recommended that a turn warning sign (W1-1) be installed on the north approach approximately 500 feet before the curve. A ball bank indicator was used to determine that 20 mph is the maximum safe speed for this curve. Therefore, 20 mph advisory speed plates (W13-1) should be posted with both turn warning signs.

2. To better identify the curve, a series of ten chevron warning signs (W1-8) should be installed on the outside of the curve. The signs should be located so they will guide motorists around the curve from both approaches. At least three chevrons should be visible to motorists at all times. The recommended sign spacing and approximate location are shown in Figure 2D.

COLLISION DIAGRAM



SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME 1400 7-05-75 DATE
WEATHER C. D DAY LIGHT
PAVEMENT

Site No. 2 COONEY DAM ROAD

Figure No. 2-C
Carbon Co.

ACCIDENT DATA

Cooney Dam Road (2.5 Miles West of Boyd)

SITE NUMBER 2 ACCIDENT PERIOD 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
2	1		2

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1		1		2	1

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	1			1			1				2

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
										1		1	1	1							1		

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
4	1		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
3			2	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
5			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			5						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1			4					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury	1			
Fatality				
Property Dam. Only	1	1		2

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1	ea	Install Turn Warning Sign (W1-1)	$130	$ 130
2	ea	Install 20 mph Advisory Speed Plate (W13-1)	$50	100
10	ea	Install Chevron Warning Signs (W1-8, 18" x 24")	$130	1,300
Total Cost:				$1,530

Benefit/Cost Ratio: 2.2

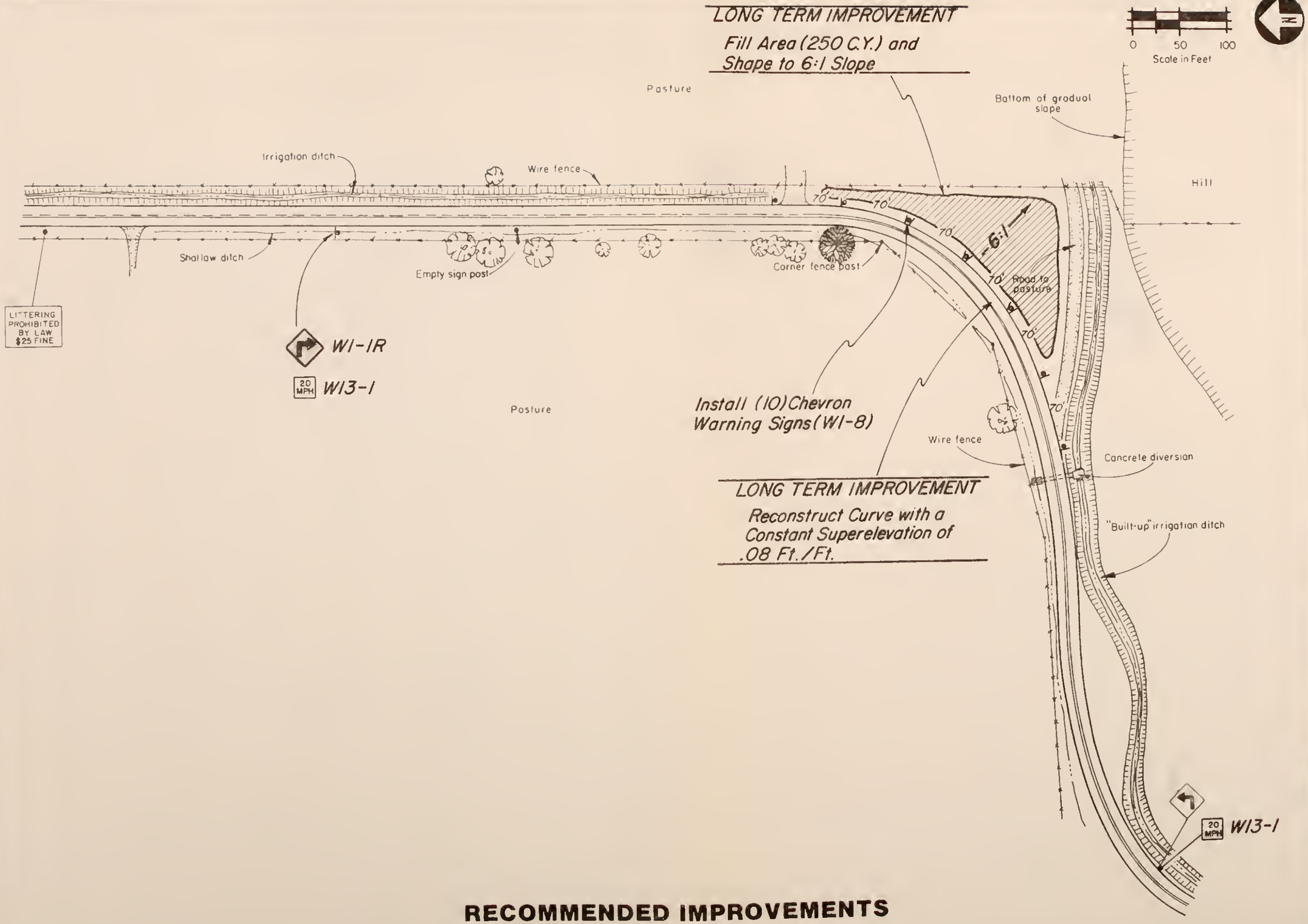
Long-Term Improvements

To a large extent, the difficulty motorists have in negotiating the curve is caused by poor design. The curve actually has two superelevations; one for the inside lane (11%), and another for the outside lane (2%). This is commonly known as a "broken back" superelevation, and is generally considered very poor design practice. Forces on a vehicle in the curve change rapidly when the centerline is crossed, often resulting in a loss of control. It is therefore recommended that this curve be reconstructed and a uniform superelevation of 0.8 ft/ft be used.

The area on the outside of the curve should be filled and reshaped. The present drop off could compound the severity of an accident by causing a vehicle to roll over if it left the road. This area should be shaped to form a 6:1 slope falling away from the road shoulder. This will provide a "run out" area for vehicles leaving the road in the curve. A total of 250 cubic yards of fill material will be required to achieve the desired slope.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Reconstruct Curve to Uniform Superelevation of .08 ft/ft	-	$8,000
250	cy	Fill and Reshape Area Outside of Curve	$4	1,000
Total Cost:				$9,000



RECOMMENDED IMPROVEMENTS

COONEY DAM ROAD

Site No. 2

Figure No. 2-D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number *2* Date *December, 1982*

Site Description *Cooney Dam Road 2.5 Miles West of Boyd*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*1.25* acc/yr	*30*	x 0.164 =	*4.92*
Accident Rate	*27.0* acc/MVE	*100*	x 0.225 =	*22.50*
Accident Severity	*12,400* dollars	*69*	x 0.191 =	*13.18*
Volume/Capacity Ratio	*.11*	*28*	x 0.082 =	*2.30*
Sight Distance Ratio	*.42* (wt. avg.)	*100*	x 0.074 =	*7.40*
Driver Expectancy	*4.5* (wt. avg.)	*75*	x 0.149 =	*11.18*
Information System Deficiencies	*4.5* (wt. avg.)	*75*	x 0.115 =	*8.63*

Hazard Index: *70.11*

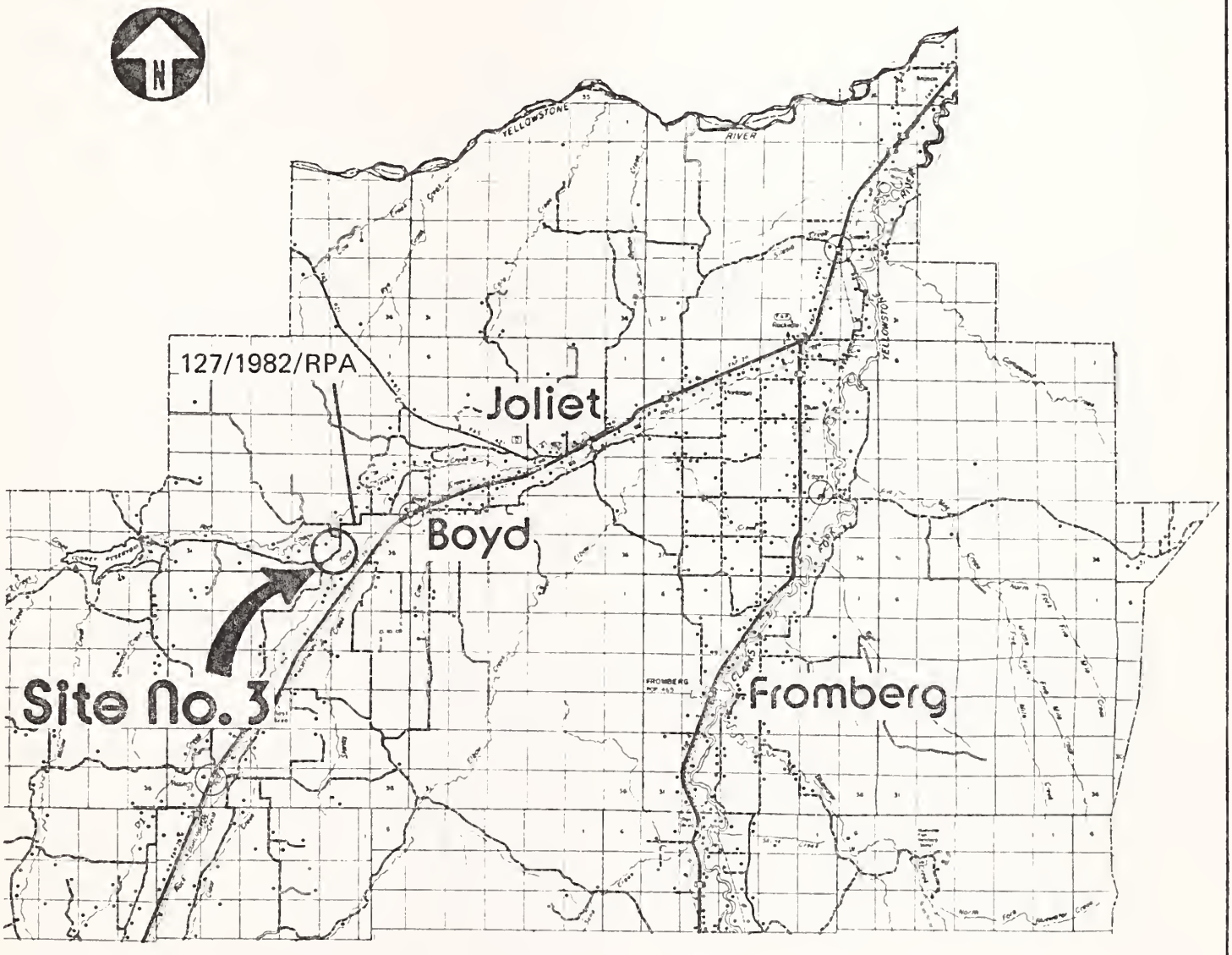
Cost of Recommended Improvements: *$1,530*

Cost Factor: *86*

Priority Index = Hazard Index x .75 + Cost Factor x .25

70.11 x .75 + *86* x .25 = *74.08*

SITE 3



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
COONEY DAM ROAD

Figure No.
3-A
Carbon Co

SITE #3

COONEY DAM ROAD
(1.9 miles west of Boyd)

A. Location

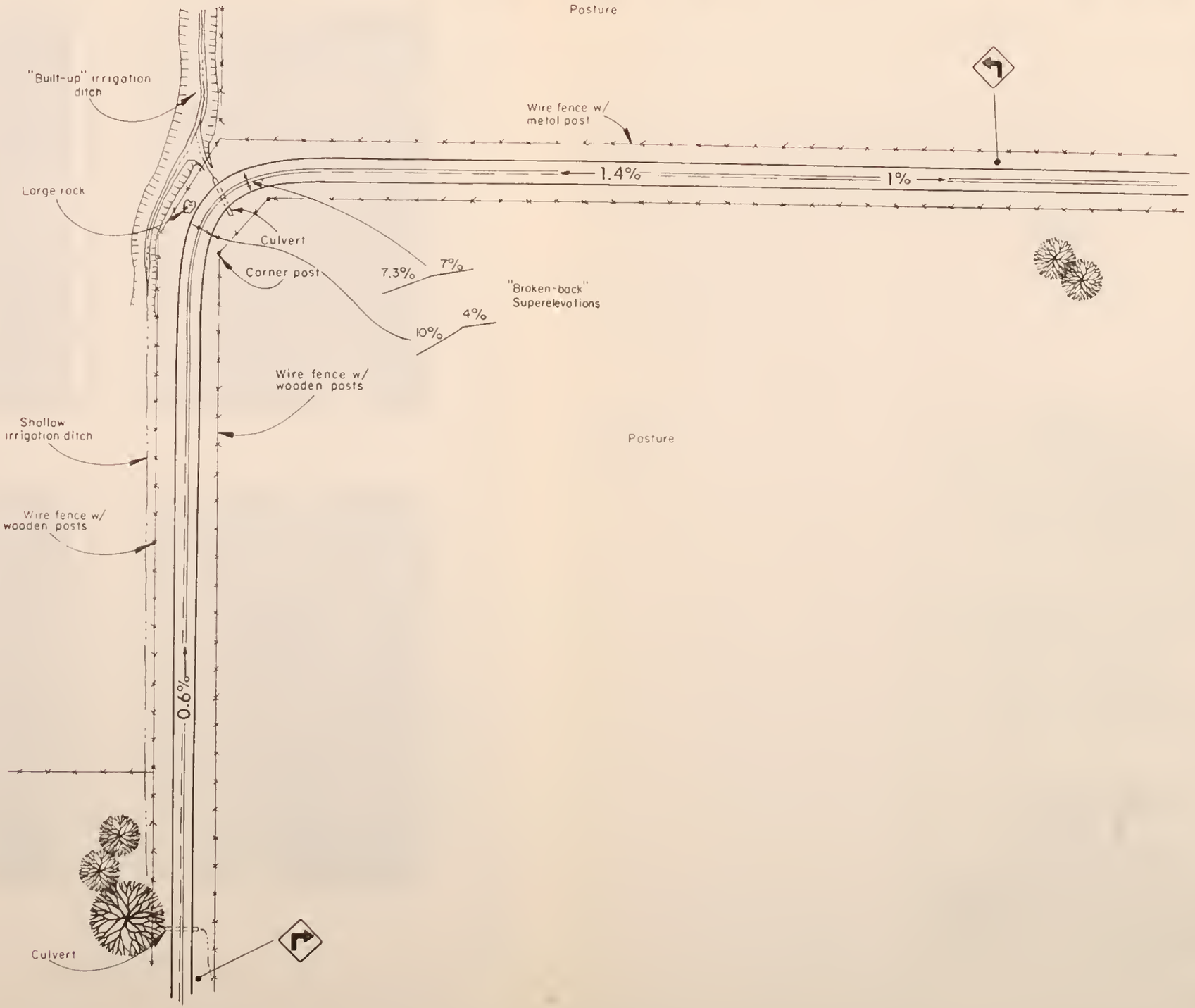
Site #3 is located on the Cooney Dam Road 1.9 miles west of Boyd in the northwestern portion of Carbon County. The site consists of a 90-degree curve and the south and east approaches to the curve. Land in the area of the site is primarily utilized for agricultural purposes; however, scattered residential development has also occurred near the site. The Cooney Dam Road is one of the primary access routes to the Cooney Reservoir State Recreation Area, and is heavily travelled by recreational traffic during the summer months. The location of this site and the available traffic count data are presented in Figure 3A.

B. Existing Conditions

The Cooney Dam Road at Site #3 has an asphalt surface that is typically 22 feet wide. Yellow centerline and white shoulder stripes delineate two 12-foot driving lanes and 1-foot shoulders. The pavement surface over most of the site is in fair condition; however, through the corner the pavement is in extremely deteriorated condition. Travel through the corner is significantly hindered by the rough condition of the pavement surface at this point. Road grades within the site are relatively flat; grades on the south approach average 0.6 percent and range between 1 and 1.5 percent on the east approach. The superelevation at the east end of the curve is steep at 7 percent. The south end of the curve has a "broken back" superelevation with 10.8 percent and 4 percent on the eastbound and southbound lanes, respectively, This "broken back" superelevation, coupled with the sharp change in direction and the poor condition of the roadway surface, significantly affects the movement of traffic through the curve. Signing at the site consists of a turn sign (W1-1R) located on the south approach to the site approximately 550 feet before the curve and a turn sign (W1-1L) located on the east approach 600 feet before the curve. There is no posted speed limit within the site. Centerline pavement striping changes within the site are depicted in the site sketch (Figure 3B) accompanying this analysis. Existing site conditions are also presented in Plate 3.

Traffic at this site was counted by Robert Peccia & Associates during November, 1982. Data obtained through use of 24-hour machine traffic counters was used to determine the average daily traffic (ADT) at this site. It was determined that the ADT for this Cooney Dam Road location is 127 vehicles.

EXISTING CONDITIONS



COONEY DAM ROAD

Site No. 3

Figure No. 3-B

Carbon Co.

Existing Site Conditions

View of south approach to the sharp curve in Site 3. Note pavement markings and advance turn warning sign.

View of the east approach to the curve. Note the advance turn warning sign and the lack of advisory speed information.

View of the area within the curve at the site. Note the deteriorated pavement condition.

The curve at the site as viewed by westbound motorists.

Plate 3

C. Accident History

A total of six accidents were reported at this site during the four-year study period extending from January, 1978 through December, 1981. One of the six accidents resulted in injuries to one person. In addition, a fatal accident in July, 1978 resulted in the death of one person. In this accident, the driver apparently entered the sharp corner too fast and was unable to negotiate the curve. The vehicle left the roadway and overturned. Five of the six accidents at the site occurred on weekends during the summer, and most involved out-of-county drivers. All six accidents occurred at night under dry and clear weather and road conditions. All accidents at the site were single-vehicle accidents in which vehicles left the roadway and struck roadside objects. Excessive speed and drinking were listed as the major contributing factors to the accidents at this site. Alcohol was involved in four of the six reported accidents. Figure 3C depicts the accident locations and summarized pertinent data for each accident at the site.

The accident rate at this site is 32.4 accidents per million vehicles entering.

D. Recommendations

This 90-degree bend in the Cooney Dam Road was the site of one fatality, one injury and four property damage accidents during the study period. In all of these accidents, vehicles left the road in the curve due to excessive speed. The short-term improvements described below focus on upgrading the signing at this site, while the long-term improvements address reconstruction of the curve.

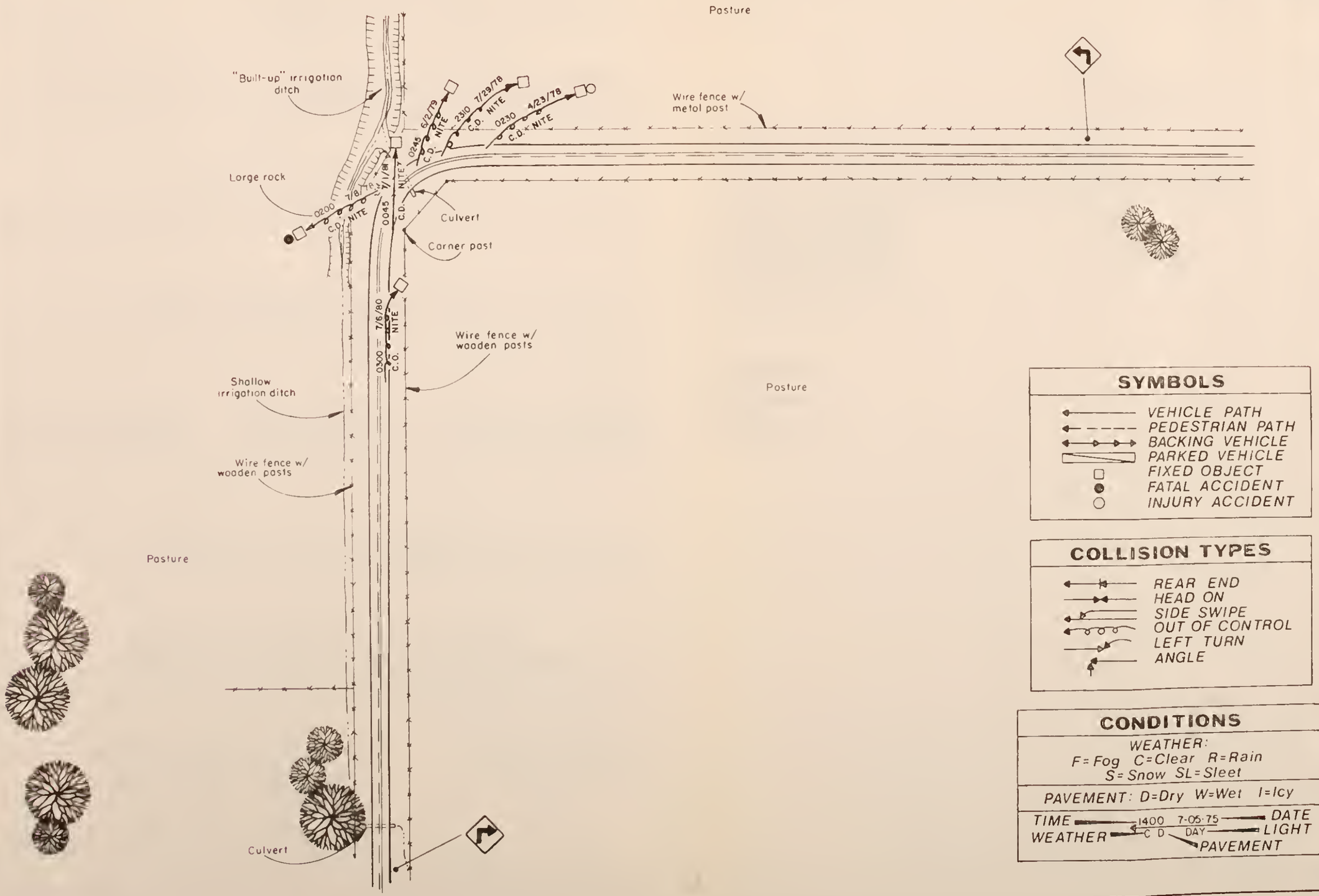
1. A vehicle equipped with a ball bank indicator was used to determine that 15 mph is the maximum safe speed for this particular curve. It is recommended that 15 mph advisory speed plates (W13-1) be mounted with the existing turn warning signs on both approaches.

2. To properly identify the location of the curve and emphasize the turn situation, it is recommended that large directional arrows (W1-6, 48" x 24") be installed. These arrows should be located so that they are visible to traffic for at least 500 feet on each approach.

3. The area on the outside of this curve drops off sharply, and could compound the severity of an otherwise minor accident by causing a roll-over. It is therefore recommended that this area be filled and reshaped to provide a 6:1 slope falling away from the edge of the road. This flat slope would be considerably safer than the present one, and would allow for a "run-out" area for vehicles leaving the road in the curve. Approximately 200 cubic yards of fill material will be required for this improvement.

COLLISION DIAGRAM

0 50 100
Scale in Feet



SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME 1400 — DATE 7-05-75
WEATHER C D — LIGHT DAY
PAVEMENT

site no. 3 COONEY DAM ROAD

Figure No. 3-C
Carbon Co.

ACCIDENT DATA

Cooney Dam Road (1.9 Miles West of Boyd)

SITE NUMBER 3 ACCIDENT PERIOD 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
3	1	1	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2			1			3

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			1		1	4					

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	3																					1	2

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
	6		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
6				

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
6			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			5		1				

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
	2		4					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury	1			
Fatality	1			
Property Dam. Only	1	1	1	1

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

4

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
2	ea	Install 15 mph Advisory Speed Plates (W13-1)	$50	$100
2	ea	Install Large Directional Arrows (W1-6, 48" x 24")	$163	326
200	cy	Fill and Slope Area on Outside of Curve	$4	800
Total Cost:				$1,226

Benefit/Cost Ratio: 5.1

Long-Term Improvements

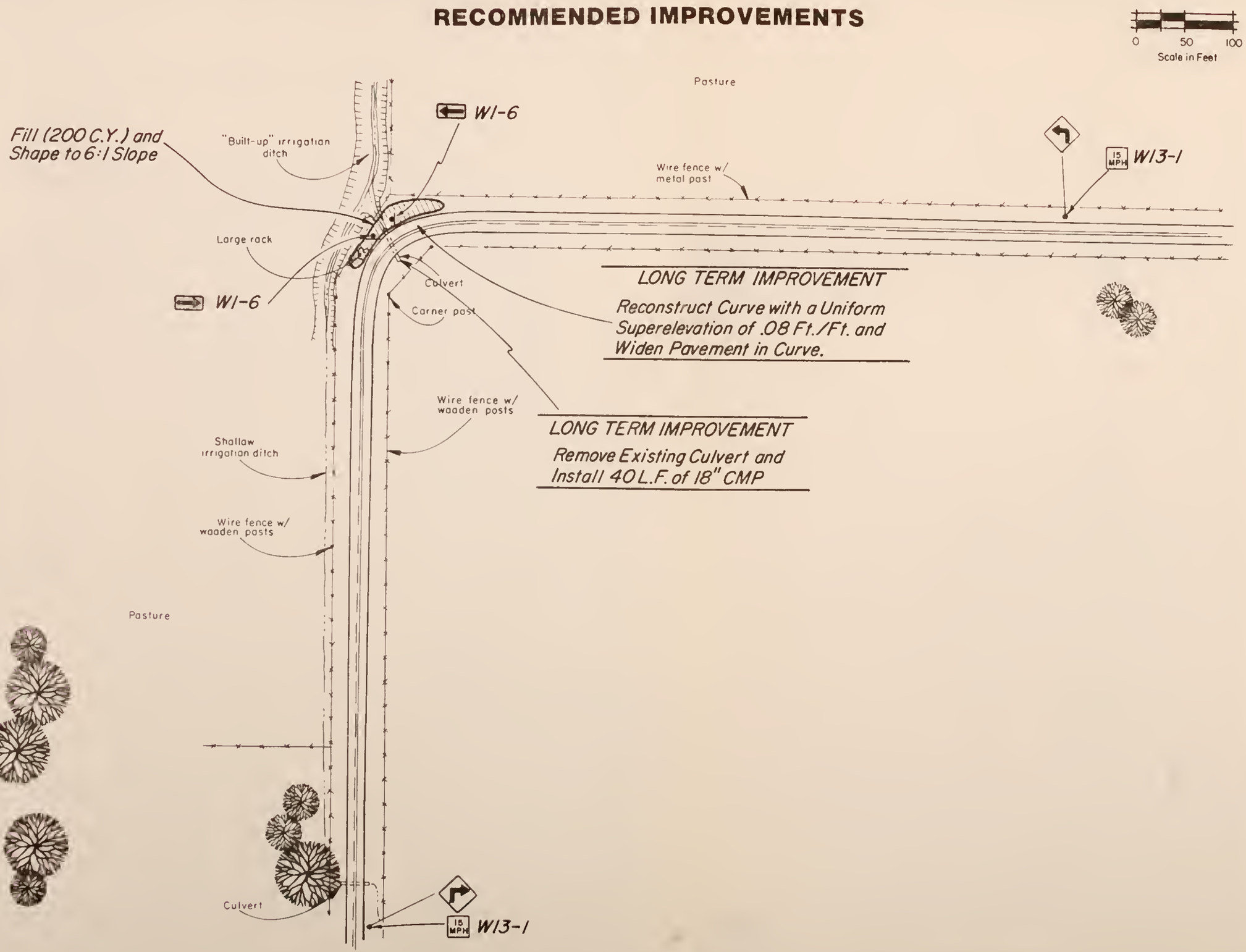
The superelevation of this curve varies from one lane to the other. The inside lane has a cross grade of almost 11 percent, while the grade in the outside lane is only 4 percent. This "broken back" superelevation should be corrected. In addition, the existing pavement surface in the curve is badly deteriorated, and resurfacing is needed. It is therefore recommended that the superelevation be reconstructed to a uniform grade of .08 ft/ft at the time the road is resurfaced. In addition, the road surface in the curve should be widened to 24 feet at this time.

The existing drainage system at this site is not functioning as designed. A 12-inch corrugated metal culvert was placed under the road in the curve to drain surface runoff from the south side of the road. At present, water accumulates on the inside of the curve, causing a maintenance problem and accelerating the deterioration of the adjacent pavement surface. At the time of the field inspection, it appeared that this culvert had been plugged for some time, and the south end of the culvert was not visible. It is recommended that the existing 12-inch culvert be removed and replaced with an 18-inch corrugated metal culvert. This larger culvert will be less prone to plugging, and will be easier to clean out. A total of 40 feet of culvert is required.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Reconstruct Curve to Uniform Superelevation of .08 ft/ft and Widen Pavement to 24 feet	-	$4,000
40	lf	Install 18" CMP	$25	1,000
Total Cost:				$5,800

RECOMMENDED IMPROVEMENTS



Site No. 3 COONEY DAM ROAD

Figure No. 3-D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number *3* Date *December, 1982*

Site Description *Cooney Dam Road 1.9 Miles West of Boyd*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*1.5* acc/yr	*33*	x 0.164 =	*5.41*
Accident Rate	*32.4* acc/MVE	*100*	x 0.225 =	*22.50*
Accident Severity	*12,400* dollars	*69*	x 0.191 =	*13.18*
Volume/Capacity Ratio	*.11*	*28*	x 0.082 =	*2.30*
Sight Distance Ratio	*2.0* (wt. avg.)	*0*	x 0.074 =	*0*
Driver Expectancy	*4.7* (wt. avg.)	*78*	x 0.149 =	*11.62*
Information System Deficiencies	*3.5* (wt. avg.)	*58*	x 0.115 =	*6.67*

Hazard Index: *61.68*

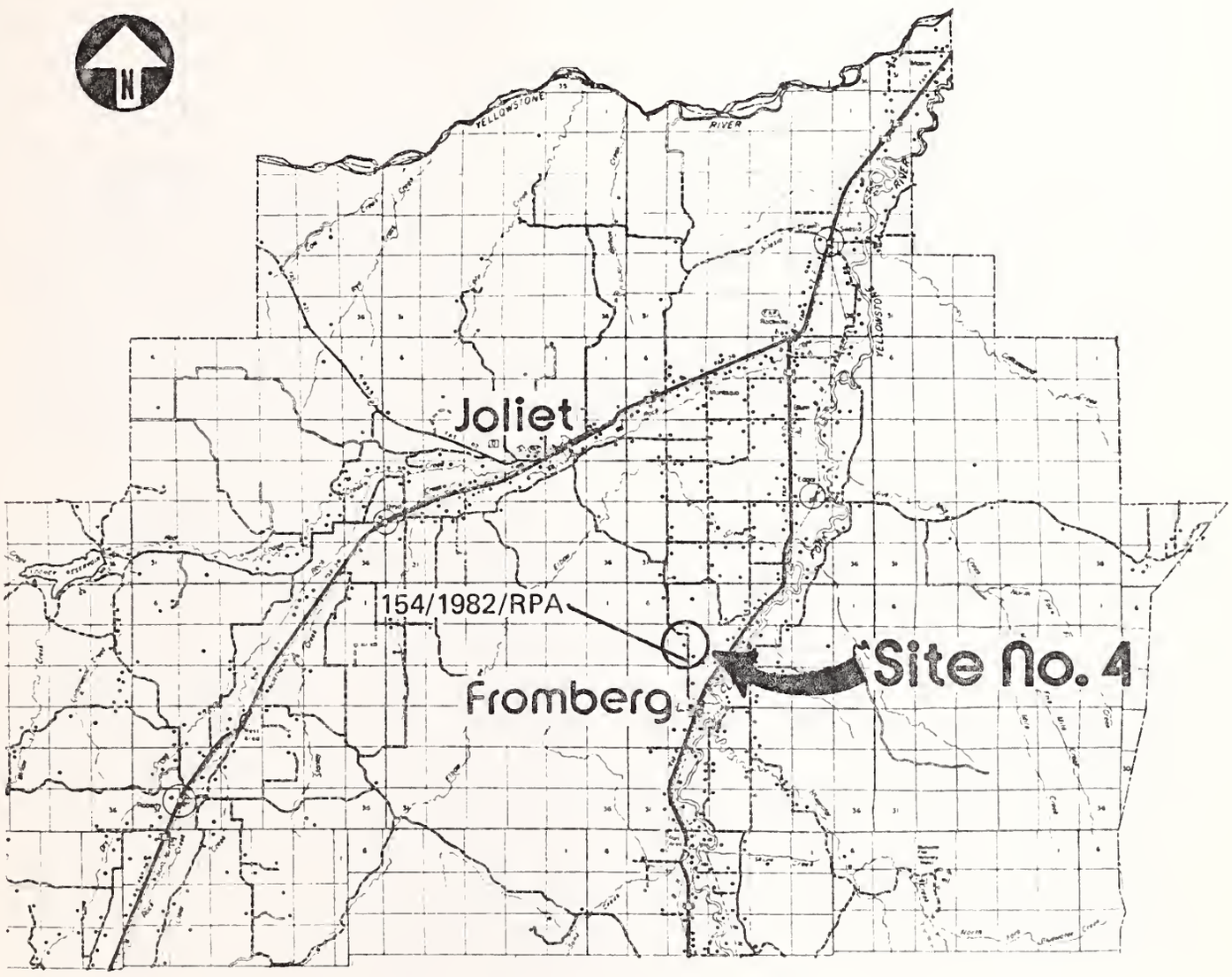
Cost of Recommended Improvements: *$1,226*

Cost Factor: *89*

Priority Index = Hazard Index x .75 + Cost Factor x .25

61.68 x .75 + *89* x .25 = *68.51*

SITE 4



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
JOLIET - FROMBERG ROAD

Figure No.
4-A
CarbonCo

SITE #4

JOLIET - FROMBERG ROAD

A. Location

Site #4 is located in the northcentral portion of Carbon County approximately 1.8 miles north of Fromberg. The site is located on the county road connecting the communities of Fromberg and Joliet, and provides a significant savings in mileage and time for motorists travelling between the two communities. Site #4 consists of a 90-degree corner and the west and south approaches to the curve. Land in the area is used primarily as pasture or cropland. The location of this site and the available traffic count data are presented in Figure 4A.

B. Existing Conditions

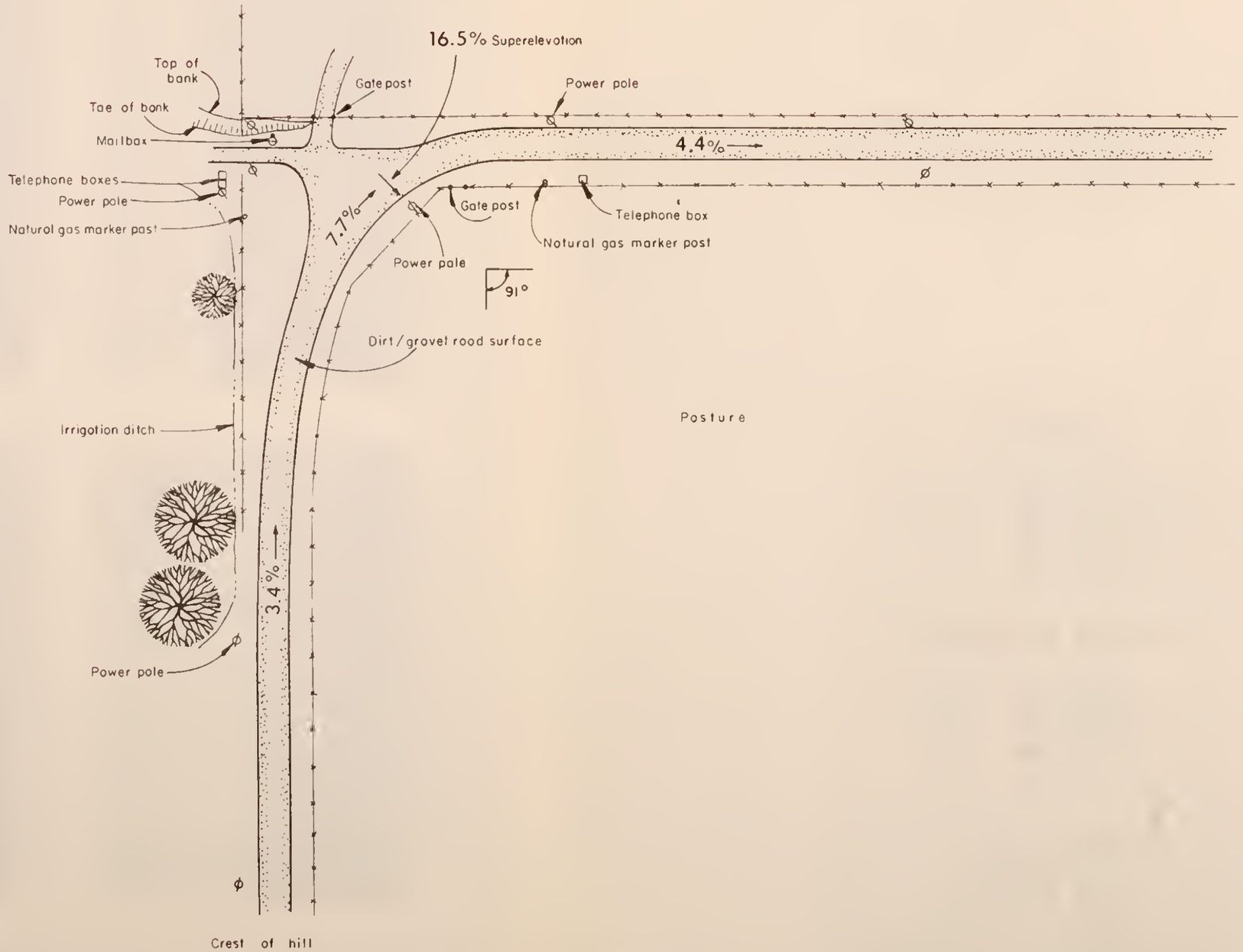
The roadway in Site #4 has a gravel surface typically 26 to 28 feet wide. Road grades on the south approach to the curve range from approximately 7.5 percent in the curve to 4.4 percent on the grade leading into the curve. Grades on the west approach are approximately 3 percent. Probably the most notable geometric characteristic of this site is the extremely steep superelevation in the curve. This 16.5 percent superelevation has virtually restricted travel through the corner to one lane. An access road serving a farm just north of the site also intersects the Joliet - Fromberg Road at this corner. At two locations within the site, obstructions are located less than eight feet from the edge of the roadway. Steep areas adjacent to the edges of the road also present a potentially hazardous situation to unwary motorists. Sight distance is limited somewhat by a hill crest on the west approach. No signing presently exists within the site. The existing conditions at Site #4 are depicted in Figure 4E and Plate 4.

Based on machine traffic counts of 24-hour traffic volumes conducted by Bob Al Peeples & Associates during November, 1982, average daily traffic (ADT) was determined to be 154 vehicles.

C. Accident History

A total of two accidents were reported at this site during the four-year study period. Both accidents resulted in injuries to a total of four persons, and involved single vehicles that left the roadway and overturned. Both accidents occurred at night, and only one occurred during adverse weather and road conditions. Drinking and excess speed for road conditions were listed as the major contributing circumstances to the accidents at this site. The composite collision diagram for this site is depicted in Figure 4C.

The accident rate for this site on the Joliet - Fromberg Road is 8.9 accidents per million vehicles entering.



EXISTING CONDITIONS

JOLIET - FROMBERG ROAD

Site No. 24

Figure No. 4-B

Carbon Co.

Existing Site Conditions

View of south approach to the curve at Site 4. Note the lack of advance warning signing.

View of the south approach to the curve. Travel speeds may be quite fast on this long tangent section leading into the curve.

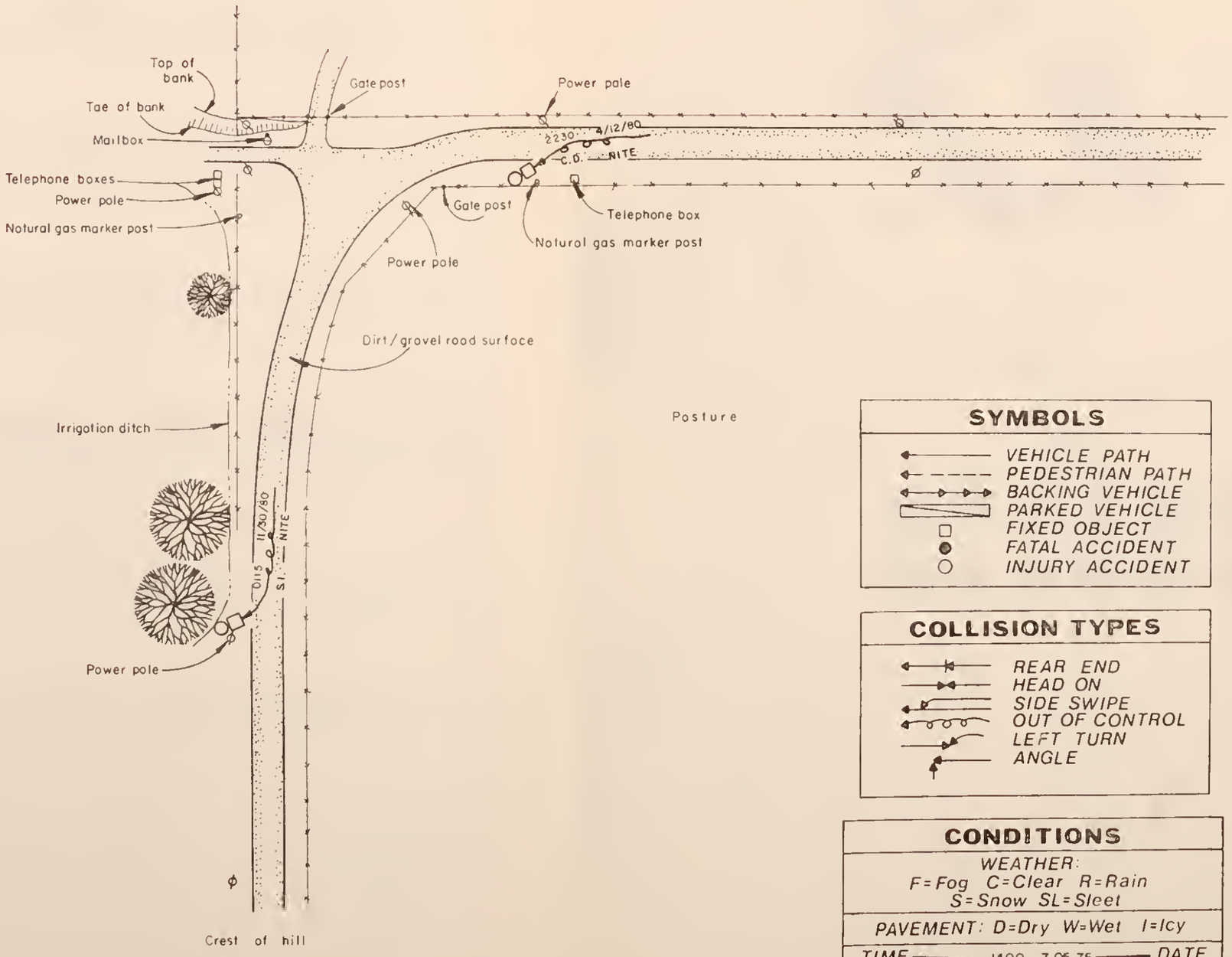
View of the curve at Site 4. The 16.5 percent superelevation in the curve restricts the width of the travel lane at this point to 15 feet.

View of the west approach to the curve. Note the lack of advance signing and the steep areas adjacent to the roadway edge.

Plate 4

COLLISION DIAGRAM

0 50 100
Scale in Feet



Posture

SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME 1400 7-05-75 DATE
WEATHER C.D DAY LIGHT
PAVEMENT

JOLIET - FROMBERG ROAD

Site No. 4

Figure No. 4-C

Carbon Co.

ACCIDENT DATA

Joliet - Fromberg Road

SITE NUMBER 4 ACCIDENT PERIOD 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
		2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
						2

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			1							1	

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1																					1		

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
	2		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
1			1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
1		1	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			2						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
	1		1					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury			2	
Fatality				
Property Dam. Only				

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

D. Recommendations

This 90-degree bend in the Joliet - Fromberg road is not identified or signed at present. Vehicles approaching from the west cannot see the curve until they are within 500 feet of it, due to the rolling terrain. Drivers approaching from the south may also be caught off-guard because of the long straight section of road before the curve. In addition to the abrupt change in alignment, the superelevation in the curve is too steep for safety. The short-term improvements listed below address these deficiencies.

1. Through the use of a ball bank indicator, it was determined that the maximum safe speed for this curve is 20 mph. The curve should be identified in advance and the appropriate speed posted. It is recommended that turn warning signs (W1-1) be installed on both approaches, with 20 mph advisory speed plates mounted along with the warning signs. The signs should be located 500 feet in advance of the beginning of the curve on each approach. This setback distance will allow enough time for drivers to react to the upcoming curve situation.

2. To further emphasize the change in roadway alignment and better identify the location of the curve, large directional arrows (W1-6) should be installed in the curve. These arrows should be located so they are clearly visible for at least 500 feet on each curve approach. The recommended placement of these directional arrows is shown in Figure 4D.

3. The extremely steep superelevation of 16.5 percent is probably the biggest hazard at this location. According to the AASHO Policy on Geometric Design of Rural Highways, a maximum superelevation of .08 ft/ft should be used where ice and snow are encountered to minimize side-slipping across the road. It is therefore recommended that this curve be reconstructed with a uniform superelevation of .08 ft/ft.

IMPROVEMENT COST ESTIMATE

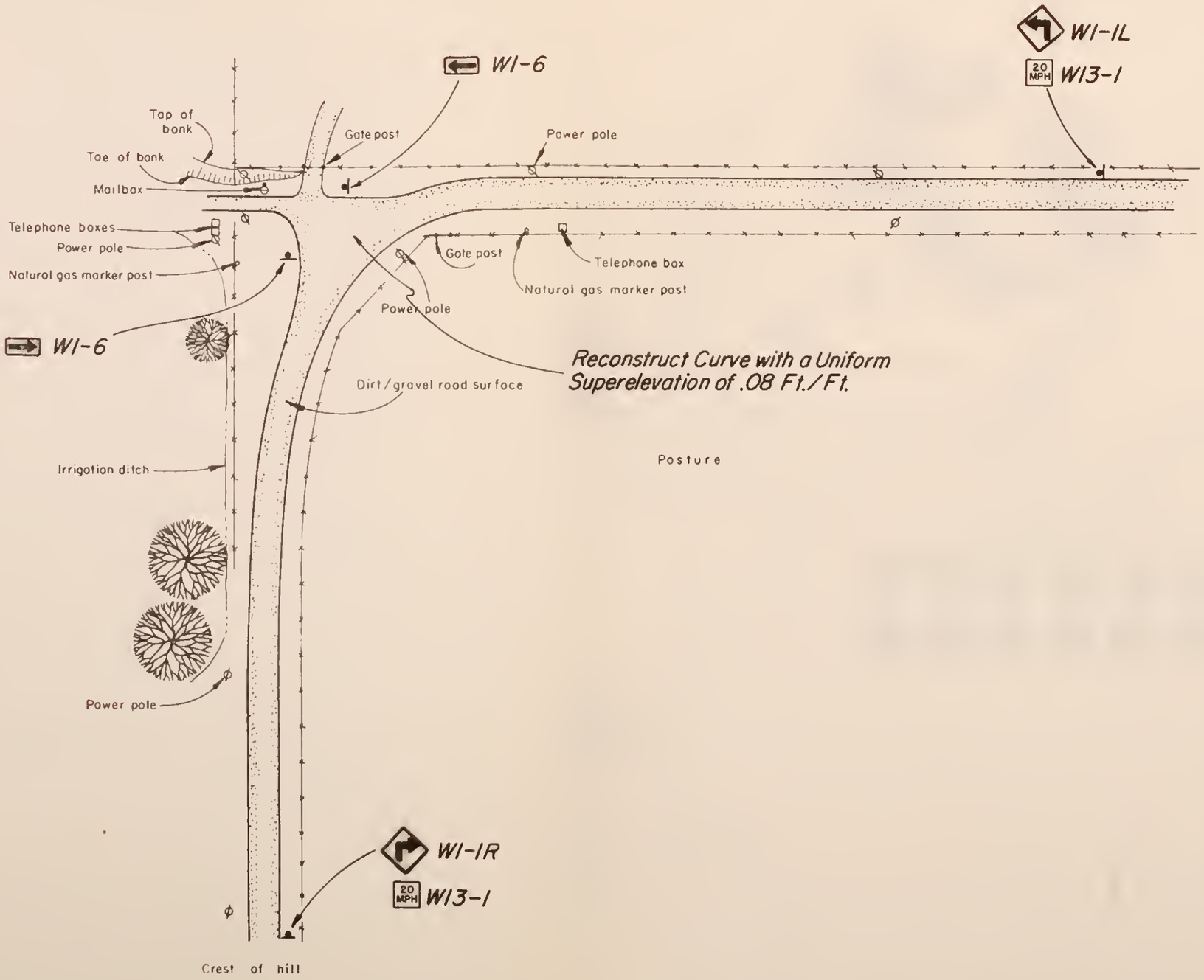
Quantity	Unit	Item Description	Unit Price	Total Price
2	ea	Install Turn Warning Signs (W1-1) with 20 mph Advisory Speed Plates (W13-1)	$180	$ 360
2	ea	Install Large Directional Arrows (W1-6, 48" x 24")	$163	326
-	Lump Sum	Reconstruct Superelevation of Curve to .08 ft/ft	-	1,000
Total Cost:				$1,686

Benefit/Cost Ratio: 3.3

Long-Term Improvements

The short-term improvements outlined previously adequately address the problems at this location; therefore, no long-term improvements have been recommended.

RECOMMENDED IMPROVEMENTS



JOLIET - FROMBERG ROAD

Site No. 4

Figure No. 4-D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number *4* Date *December, 1982*

Site Description *Fromberg - Joliet Road*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*0.5* acc/yr	*17*	x 0.164 =	*2.79*
Accident Rate	*8.9* acc/MVE	*96*	x 0.225 =	*21.60*
Accident Severity	*11,450* dollars	*66*	x 0.191 =	*12.61*
Volume/Capacity Ratio	*.08*	*24*	x 0.082 =	*1.97*
Sight Distance Ratio	*.89* (wt. avg.)	*42*	x 0.074 =	*3.11*
Driver Expectancy	*3.8* (wt. avg.)	*63*	x 0.149 =	*9.39*
Information System Deficiencies	*6.0* (wt. avg.)	*100*	x 0.115 =	*11.50*

Hazard Index: *62.97*

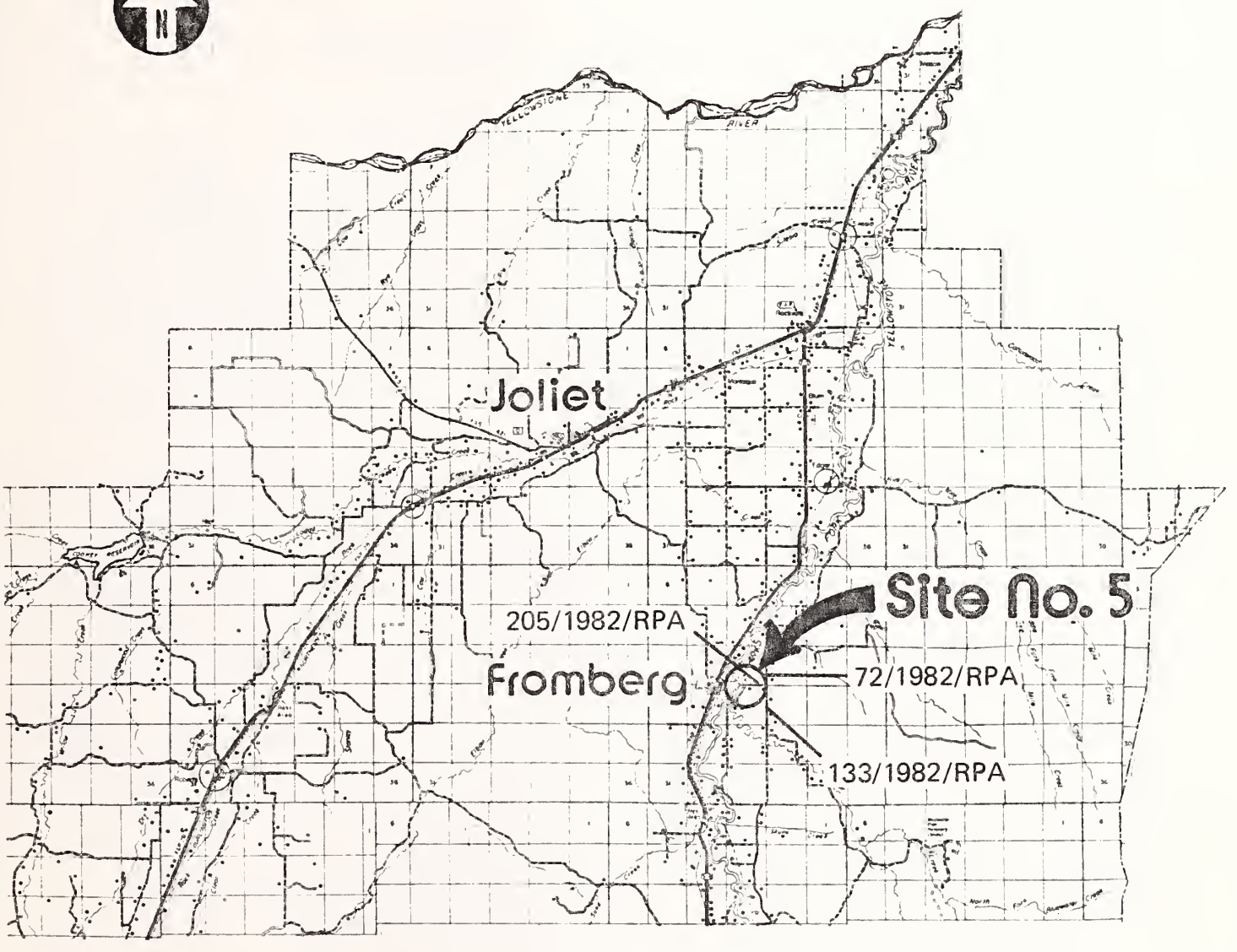
Cost of Recommended Improvements: *$1,686*

Cost Factor: *88*

Priority Index = Hazard Index x .75 + Cost Factor x .25

62.97 x .75 + *88* x .25 = *69.23*

SITE 5



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
CLARKS FORK BRIDGE

Figure No.
5-A
Carbon Co

SITE #5

CLARKS FORK BRIDGE AT FROMBERG

A. Location

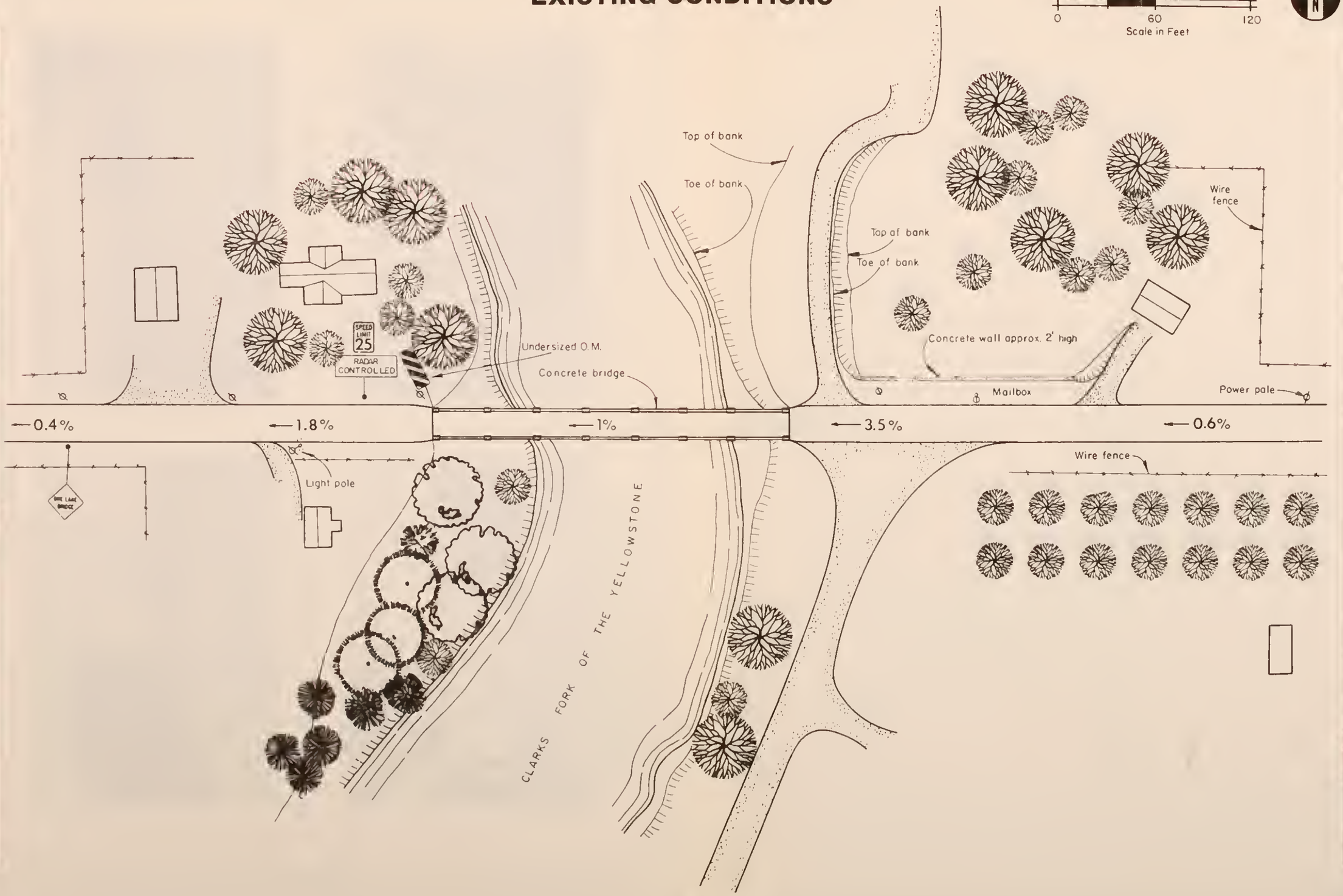
Site #5 is located 0.5 miles east of US 310 (FAP 4) at Fromberg and consists of the Clarks Fork of the Yellowstone River bridge and both its approaches. The site is located on the eastern edge of the community in a moderately developed residential area. In addition to residential uses in the area, two large farming and livestock operations are located on the east side of the river. The location of this site and the existing traffic count data are presented in Figure 5A.

B. Existing Conditions

Site #5 has an asphalt pavement surface typically 24 feet wide, which is not striped and is in fair condition on both approaches to the bridge. The roadway surface on the bridge itself is very deteriorated, probably because of drainage problems. Road grades on the east approach fall toward the bridge and range from 0.6 percent east of the bridge to 3.5 percent at the east end of the bridge. The bridge surface itself has a general grade of 1 percent to the west. Grades on the west approach vary from 1.8 percent at the bridge to 0.4 percent further to the west. Signing on the west approach consists of a "One-Lane Bridge" sign (W5-3) located about 240 feet from the bridge and a "Speed Limit - 25" sign (R2-1) intended for motorists traveling towards Fromberg. No signing exists on the east approach to the bridge.

The Clarks Fork Bridge is an arched concrete structure 15.5 feet wide and 218 feet long. The structure was built in 1914, and is considered a historical structure. The bridge deck has been covered with a four-inch layer of asphalt, which is in quite deteriorated condition. The Montana Department of Highways Bridge Evaluation Bureau appraised the structural condition of the bridge during February, 1982. The report issued after this appraisal noted numerous cracks and scaling at bridge piers and abutments, and listed the bridge alignment as poor. The bridge superstructure was listed as being in fair condition. The bridge deck has some longitudinal cracks, and inadequate drainage on the bridge has resulted in numerous chuckholes. The safety features of the bridge were also listed as being in poor condition. One undersized object marker is located on the west end of the bridge. The transition from a 23-foot-wide roadway to the narrow bridge, coupled with the sight distance limitations at the bridge, constitute a difficult situation for motorists. During the field observation, it was noted that both concrete railings have been severely damaged in numerous collisions. In summary, according to the Department of Highways, the substructure, superstructure and safety features of this bridge are in generally poor condition. The existing conditions at Site #5 are depicted in the site sketch (Figure 5B) and site photographs (Plate 5) which accompany this analysis.

EXISTING CONDITIONS



CLARKS FORK BRIDGE AT FROMBERG

Site No. 5

Figure No. 5-B

Carbon Co.

Existing Site Conditions

View of the west approach to the Clarks Fork Bridge near Fromberg. Note advance signing for bridge.

View of the east approach to the bridge. Advance warning information for the one-lane bridge is lacking on this approach.

View from the west end of the bridge. The concrete bridge was built in 1914 and is 15.5 feet wide and 220 feet long. Note the undersized object marker to the left and the missing marker on the right.

Both ends of the bridge have been damaged over the years through numerous collisions with vehicles.

Plate 5

Twenty-four-hour machine counts of traffic at this site were collected by Robert Peccia & Associates during November, 1982. This data was used to determine that the average daily traffic (ADT) for this site is 205 vehicles.

C. Accident History

Two accidents were reported at the Clarks Fork Bridge during the four-year study period. Neither accident resulted in any injuries. Both accidents occurred at night during the winter under snowy and icy road conditions. The most serious accident at this site was a head-on collision which occurred at the west end of the bridge. The vehicle approaching from the west was unable to stop due to icy road conditions and collided with a westbound vehicle on the narrow bridge. The other reported accident at this site occurred when an eastbound vehicle left the roadway just east of the bridge. This accident occurred during adverse winter weather conditions, and excessive speed for road conditions was listed as the major contributing circumstance to this accident, as well as the other accident at this site. Alcohol was also involved in one of the two accidents at this location. The composite collision diagram for Site #5 is depicted in Figure 5C.

The accident rate for this site is 6.7 accidents per million vehicles entering.

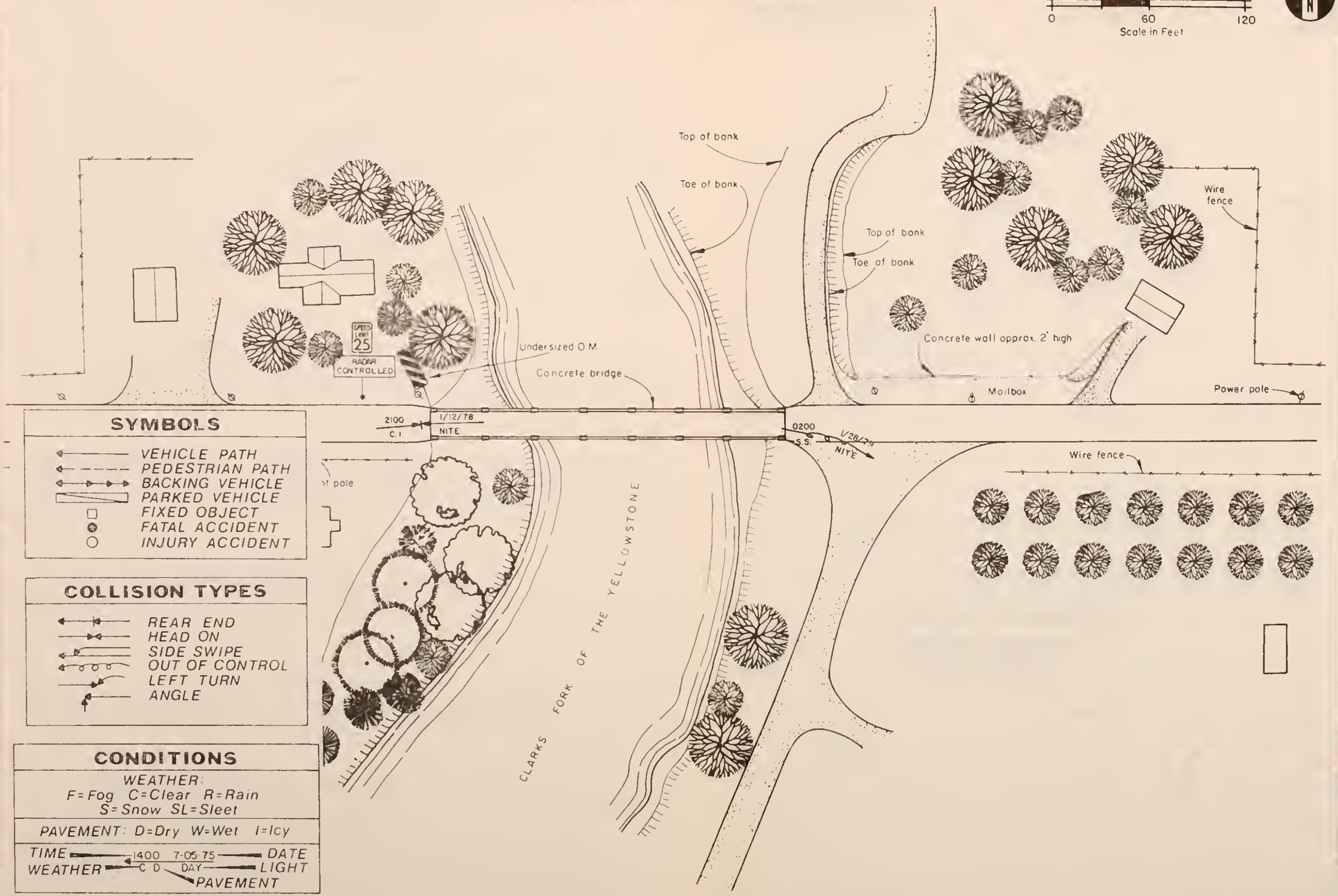
D. Recommendations

A close look at the ends of this one-lane bridge indicates that many vehicles have experienced difficulty crossing this structure. At present, the bridge signing is inadequate, and the short-term improvements concentrate on upgrading this particular deficiency. The long-term improvements attempt to improve the road surface and drainage of the bridge, thereby increasing its safety. The short-term improvements are as follows:

1. The west approach to the bridge from Fromberg has an appropriate and properly located one-lane bridge sign. Unfortunately, the east approach has no such signing. It is recommended that a one-lane bridge sign (W5-3) be installed 350 feet east of the bridge. This location is considered optimum, since it is at the crest of the hill where the bridge is visible to approaching motorists but while enough time is still available to react to the upcoming situation.

2. At present, only one of the four bridge rail ends is marked with an object marker, but this marker is undersized. Standard-sized (12" x 36") object markers should be used. The undersized object marker should be removed and new object markers (OM-3) installed on all four bridge railing ends. These markers are a tremendous aid to motorists who are trying to align a vehicle with the bridge on the approach.

COLLISION DIAGRAM



SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME — 1400 — 7-05-75 — DATE
WEATHER — C — D — DAY — LIGHT
PAVEMENT

CLARKS FORK BRIDGE AT FROMBERG

Site No. 5

Figure No.
5-C
Carbon Co.

ACCIDENT DATA

Clarks Fork Bridge at Fromberg

SITE NUMBER 5 ACCIDENT PERIOD 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
1	1		

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1				1		

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2											

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1																			1			

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
	2		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
		1	1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
1		1	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
							1	1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
			2					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury				
Fatality				
Property Dam. Only	1	1		

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1	ea	Install One-Lane Bridge Warning Sign (W5-3)	$130	$130
1	ea	Remove Existing Undersized Object Marker	$35	35
4	ea	Install Object Markers (OM-3, 12" x 36")	$130	520
Total Cost:				$685

Benefit/Cost Ratio: 1.3

Long-Term Improvements

The road surface on the bridge itself is of particular concern. Both of the accidents reported at this site during the four-year study period occurred under snowy or icy road conditions. Since there are no drainage facilities on this bridge, water and snow tend to accumulate in the driving lanes. In addition, the presence of a build up of debris along the edge of the travelways tends to compound this situation by making the driving lanes lower than the shoulders. The pavement on the bridge is deteriorated, and should be resurfaced in the near future. When this is done, it is recommended that a new road section be created. The pavement should be applied with a defined 2 percent crown in the center so that water and snow buildup will occur on the edge of the roadway instead of in the travel lanes. However, debris along the edge of the road will adversely affect this drainage, so it will have to be periodically removed.

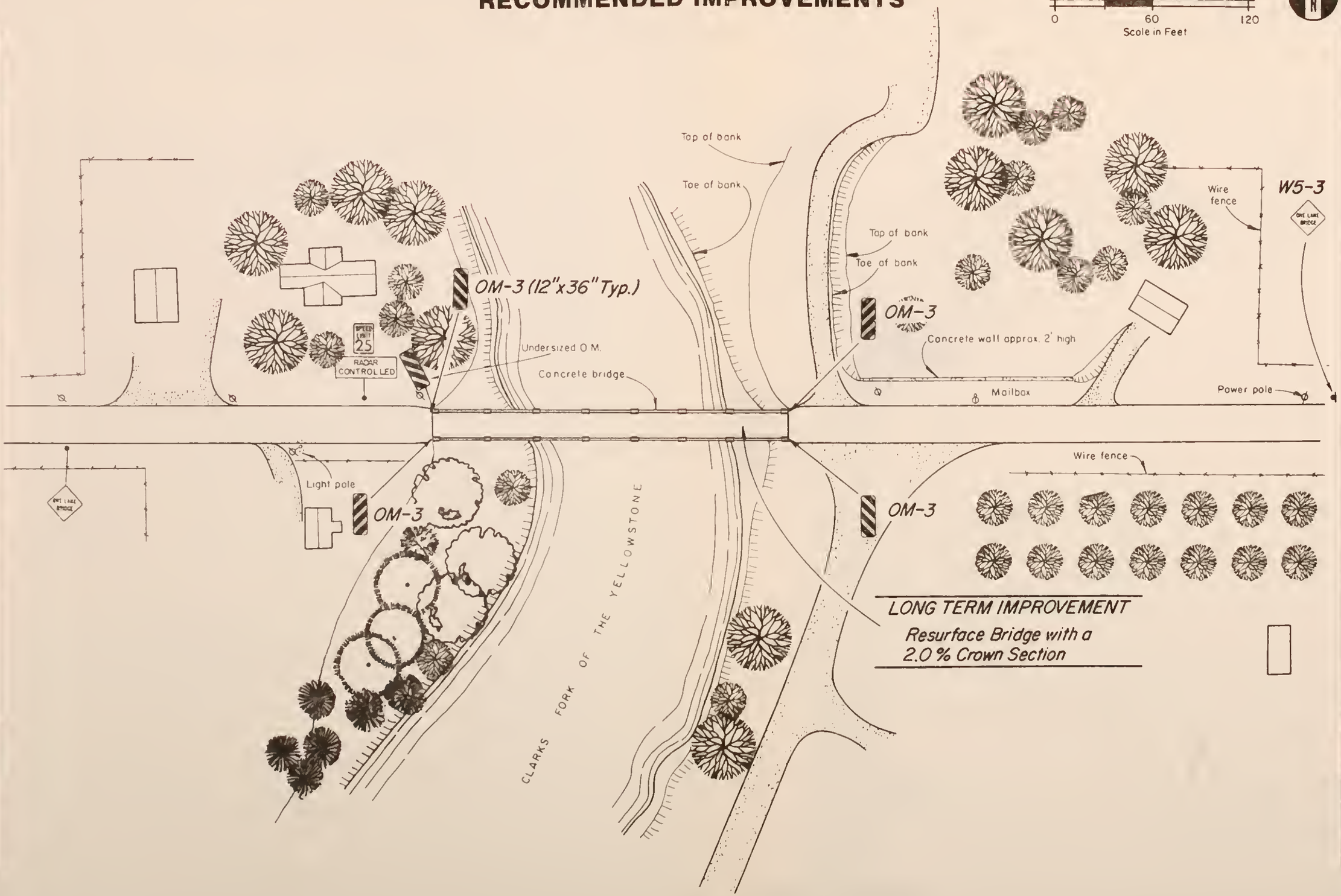
The most recent Department of Highways bridge report indicates that although this structure is still structurally sound enough for traffic loads, it is in poor condition. Due to the historical nature of the bridge, premature removal of the structure seems unlikely, and will probably only occur after the State declares that the bridge is structurally unsound. The option of building an adjacent structure is also unlikely, due to the developed nature of the surrounding area. It is recommended that the old bridge be removed when it is finally declared structurally unsafe, and be replaced with a two-

lane structure. Due to the uncertain time frame associated with this improvement, it is strongly suggested that the other short- and long-term improvements outlined above be implemented as soon as possible to provide for safe travel in the interim.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Resurface Bridge	-	$3,500

RECOMMENDED IMPROVEMENTS



CLARKS FORK BRIDGE AT FROMBERG

Site No. 5

Figure No. 5-D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number 5 Date December, 1982

Site Description Clarks Fork Bridge at Fromberg

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	0.5 acc/yr	17	x 0.164 =	2.79
Accident Rate	6.7 acc/MVE	81	x 0.225 =	18.23
Accident Severity	9,300 dollars	62	x 0.191 =	11.84
Volume/Capacity Ratio	.25	42	x 0.082 =	3.44
Sight Distance Ratio	1.5 (wt. avg.)	9	x 0.074 =	0.67
Driver Expectancy	3.7 (wt. avg.)	62	x 0.149 =	9.24
Information System Deficiencies	3.5 (wt. avg.)	58	x 0.115 =	6.67

Hazard Index: 52.88

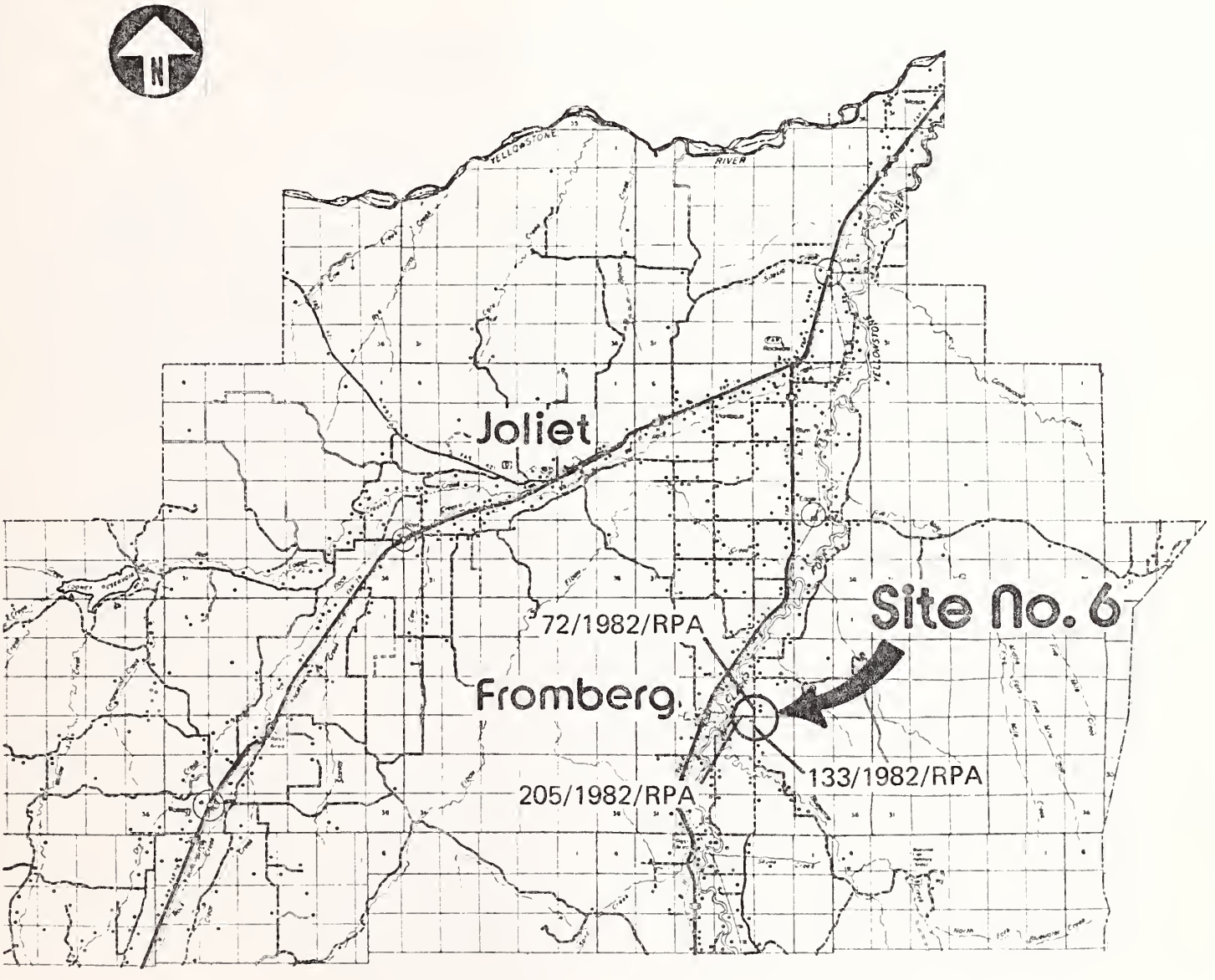
Cost of Recommended Improvements: $685

Cost Factor: 96

Priority Index = Hazard Index x .75 + Cost Factor x .25

52.88 x .75 + 96 x .25 = 63.66

SITE 6



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
"T" INTERSECTION · FROMBERG

Figure No.
6·A
Carbon Co

SITE #6

"T" INTERSECTION EAST OF FROMBERG

A. Location

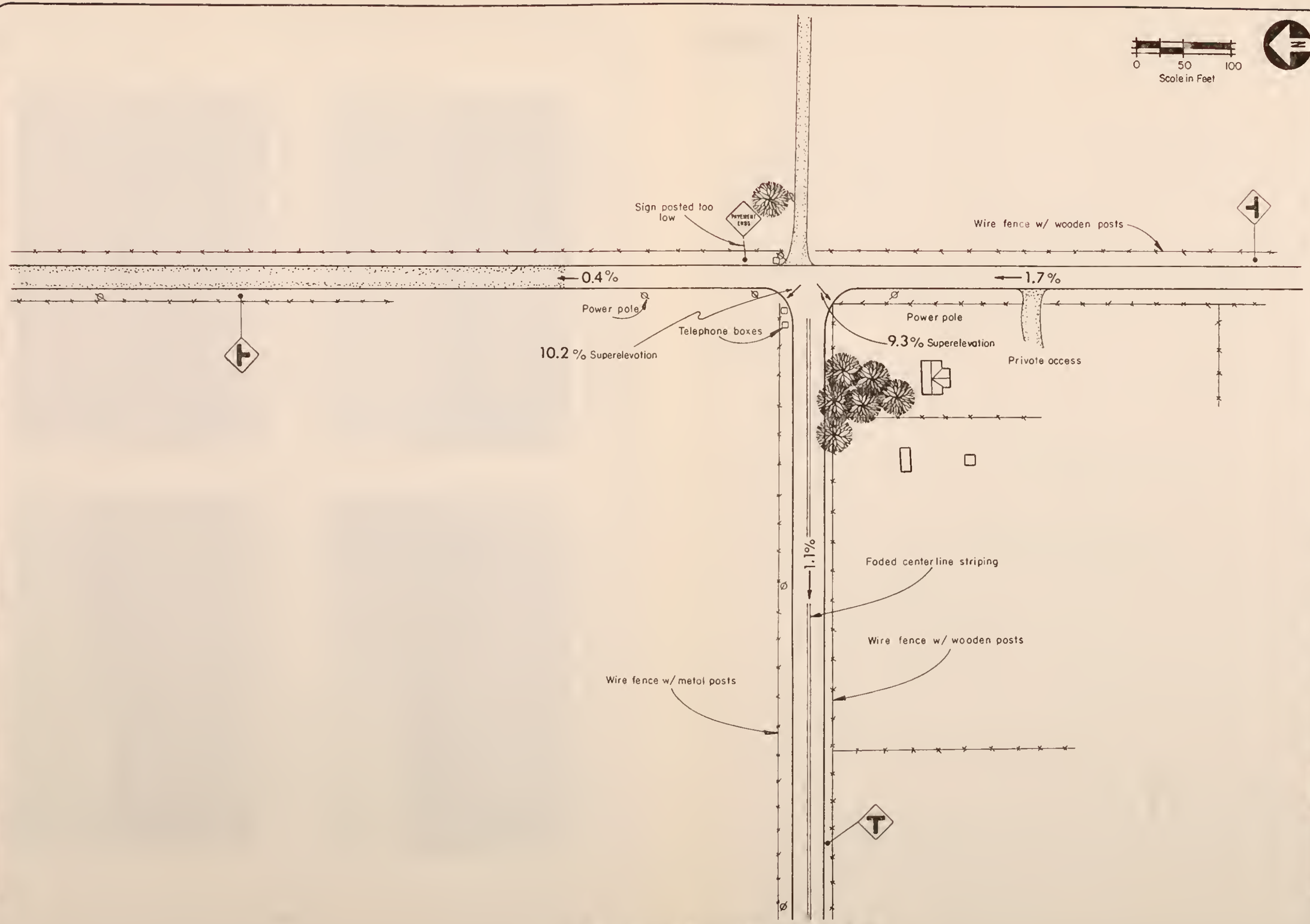
Site #6 is located 1.3 miles directly east of US 310 (FAP 4) at Fromberg. The site is situated in a lightly developed agricultural area in the northcentral portion of Carbon County. Land in the area is primarily used for irrigated cropland or for scattered residential development. The roadways at this site serve as farm-to-market routes for local ranchers and farmers. The location of this site and traffic data collected for each leg of the intersection are presented in Figure 6A.

B. Existing Conditions

The west leg of the intersection has an asphalt pavement surface that is typically 25 feet wide. Pavement striping on this leg, although quite worn, delineates two 12-foot driving lanes. Pavement condition on this approach is fair. The grade on the west approach is approximately 1 percent toward the west. The superelevations at the intersection vary between 9 and 10 percent for both north- and southbound motorists. Turning movements over the years have produced rather steep superelevations in the corners and an extremely crowned roadway section at the intersection. The south approach has an unstriped asphalt pavement surface 23 feet wide that is in fair condition. Road grades on this approach slope toward the north at approximately 1.7 percent. The north approach is paved for a distance of 225 feet from the intersection; the remainder of the north approach is a 25-foot-wide gravel road with a typical grade of 0.4 percent to the north. Abrupt road edges on all approaches present a somewhat hazardous situation for unwary motorists.

Signing on the west approach consists of a "T" symbol sign (W2-4) located approximately 600 feet from the intersection. Signing on the north approach consists of another "T" symbol sign intended for southbound motorists and a "Pavement Ends" sign (W8-3) for northbound drivers. Signing on the south approach consists of a similar "T" symbol sign. These "T" signs are effective, but side road signs (W2-2) are considered more appropriate for this location. The existing "T" symbol signs on the north and south approaches are also mounted lower than the accepted standard mounting height of five feet above the roadway surface. The existing conditions at this site are depicted in the site sketch (Figure 6B) and site photographs (Plate 6) contained in this analysis.

Based on machine counts of 24-hour traffic volumes collected by Robert Peccia & Associates during November, 1982, average daily traffic (ADT) for each leg of the intersection was determined. The ADT for the west approach was determined to be 205 vehicles. The ADT on the north and south approaches were 72 vehicles and 133 vehicles, respectively.



EXISTING CONDITIONS

Site No. 6 EAST OF FROMBERG "T" INTERSECTION

Figure No. 6-B

Carbon Co

Existing Site Conditions

View of signing on the west approach to the intersection. The pavement markings at the site were badly worn at the time of the field inspection.

View of the south approach to the intersection. Note the incorrect usage of the "T" intersection warning sign and the non-standard mounting height for the sign.

Roadside vegetation limits sight distance for motorists approaching the intersection from the west.

View of the north approach to the intersection. The signing on this approach is also mounted below the accepted mounting height of 5 feet.

Plate 6

C. Accident History

One accident was reported at this site during the four-year study period. This accident occurred when the driver of an eastbound vehicle failed to turn at the intersection. As a result, the vehicle left the roadway and went through a fence adjacent to the roadway. The accident occurred at night under clear and dry weather and road conditions. The major contributing circumstance to this accident was listed as excess speed; alcohol was also involved. Data pertinent to this accident and its location are presented in Figure 6C.

The accident rate at this site is 4.1 accidents per million vehicles entering.

D. Recommendations

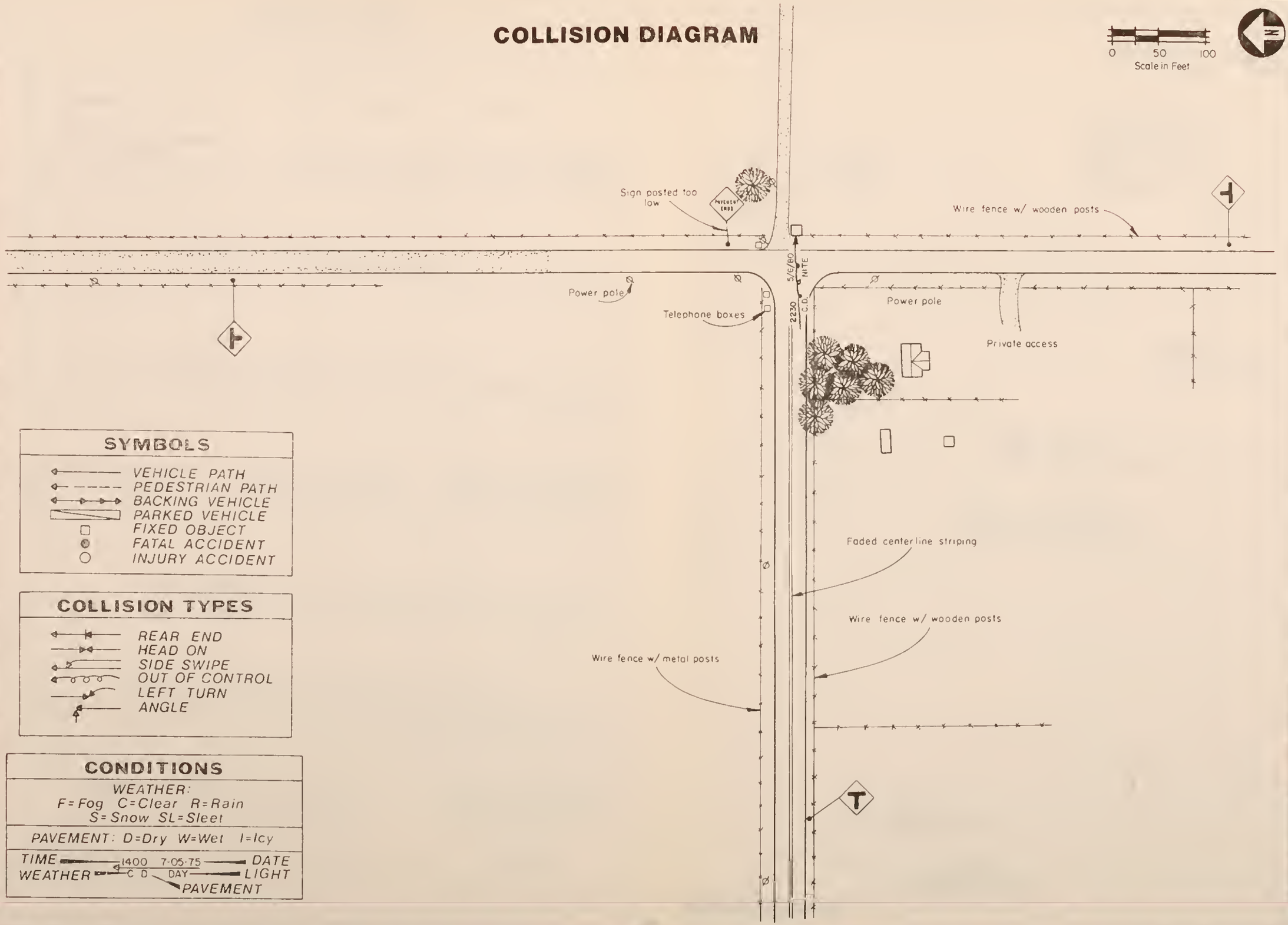
This "T" intersection has existing signing for approach traffic, but the warning signs are too small to be effectively. The short-term improvements listed below concentrate on upgrading the signing system to meet state standards.

1. The existing intersection warning signs located on all three approaches are not regulation size. The 24" x 24" sign being used is generally considered too small to be fully effective. In addition, the signs being used on the north and south approaches are "T" intersection signs (W2-4) mounted sideways to represent side road warning signs. These signs are mounted below the standard mounting height of five feet above the pavement surface. It is recommended that all three intersection warning signs be removed. A 30" x 30" "T" intersection warning sign (W2-4) should be installed on the west approach 500 feet before the intersection, and side road warning signs (W2-2, 30" x 30") should be installed 500 feet from the intersection on the north and south approaches. For additional information on standard sign sizes and proper mounting heights, please refer to the Manual On Uniform Traffic Control Devices.

2. To further emphasize the "T" intersection configuration and accurately locate the intersection for approaching motorists, a large double directional arrow sign (W1-6) should be installed. This sign should be located on the east side of the intersection directly across from the west approach lane. In this position, the sign should be clearly visible to approaching traffic for at least 500 feet from the intersection.

3. At the present time, there is no form of traffic control at this intersection. It is recommended that a yield sign (R1-2) be installed on the west approach. Since sight distance is not restricted on this approach and since traffic volumes are low, a stop sign is not considered necessary. The yield sign will not only control the traffic flow but will also help to identify the location of the intersection. To ensure that the yield sign is visible to approaching traffic, the trees and low hanging tree branches adjacent to the west approach on the south side of the road should be pruned back. The yield sign should be clearly visible for 500 feet back on the west approach.

COLLISION DIAGRAM



SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME — 1400 — DATE
WEATHER — C D — DAY — LIGHT
PAVEMENT

site no. 6
EAST OF FROMBERG
"T" INTERSECTION

Figure No.
6-C
Carbon Co

ACCIDENT DATA

"T" Intersection East of Fromberg

SITE NUMBER 6 ACCIDENT PERIOD 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
		1	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
		1				

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
				1							

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
																					1		

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
	1		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
1				

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
1			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			1						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
			1					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury				
Fatality				
Property Dam. Only			1	

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

4. The "Pavement Ends" warning sign (W8-3) located adjacent to the intersection on the north leg is mounted too low. It is recommended that this sign be reset to the standard mounting height of five feet.

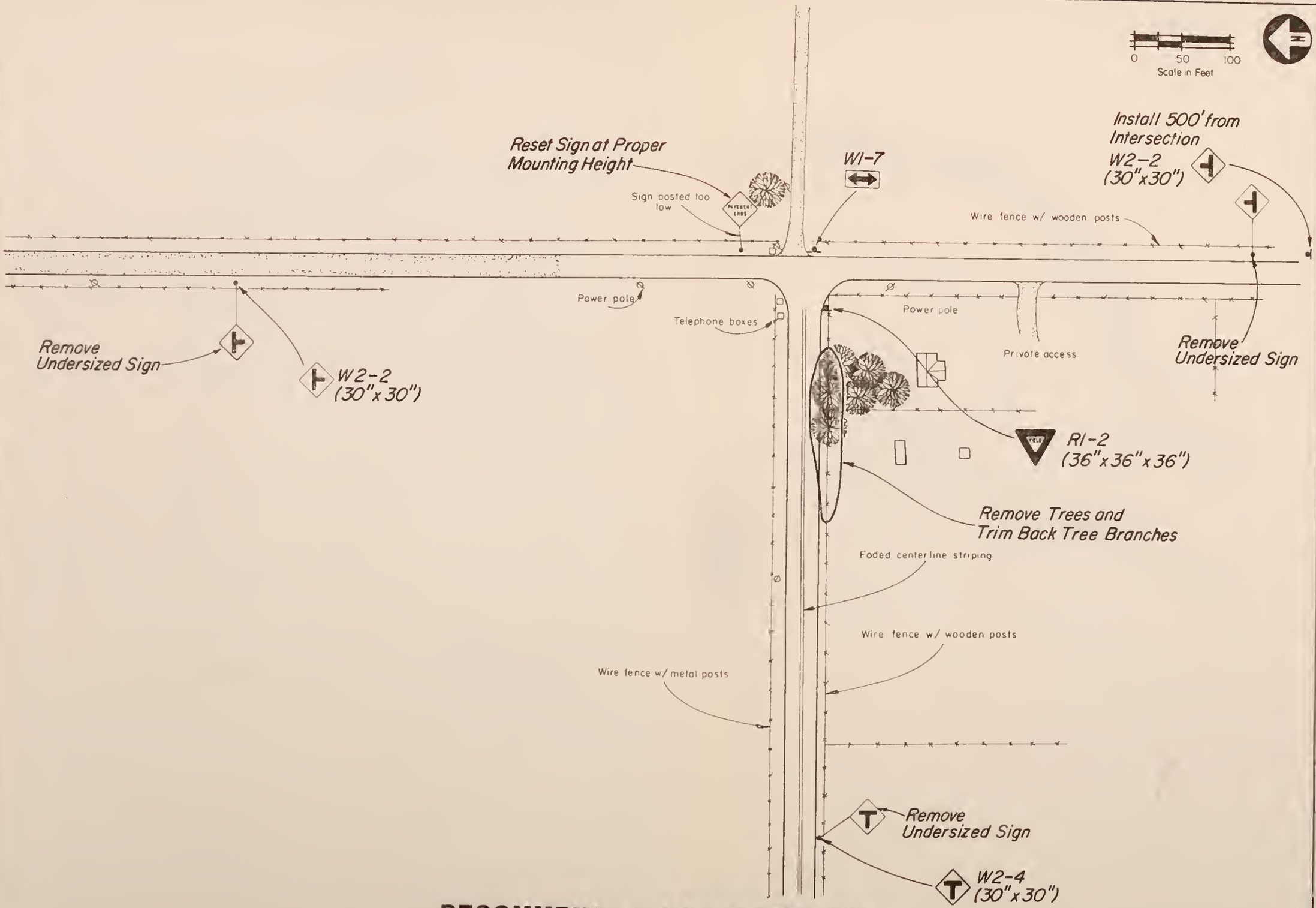
IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
3	ea	Remove Existing Intersection Warning Signs (24" x 24")	$35	$105
1	ea	Install "T" Intersection Warning Sign (W2-4, 30" x 30")	$130	130
2	ea	Install Side Road Warning Sign (W2-2, 30" x 30")	$130	260
1	ea	Install Large Double Directional Arrow Warning Sign (W1-7, 24" x 48")	$163	163
1	ea	Install Yield Sign (R1-2, 36" x 36" x 36")	$130	130
-	Lump Sum	Remove Trees and Prune Tree Limbs	-	300
1	ea	Reset Existing "Pavement Ends" Warning Sign	$70	70
Total Cost:				$1,158

Benefit/Cost Ratio: 0.4

Long-Term Improvements

The short-term improvements outlined above adequately address the problems at this site; therefore, no long-term improvements are recommended.



RECOMMENDED IMPROVEMENTS

Site No. 6 • EAST OF FROMBERG • "T" INTERSECTION

Figure No. 6•D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number 6 Date December, 1982

Site Description "T" Intersection East of Fromberg

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	0.25 acc/yr	12	x 0.164 =	1.97
Accident Rate	4.1 acc/MVE	65	x 0.225 =	14.63
Accident Severity	12,300 dollars	69	x 0.191 =	13.18
Volume/Capacity Ratio	.07	22	x 0.082 =	1.80
Sight Distance Ratio	1.33 (wt. avg.)	15	x 0.074 =	1.11
Driver Expectancy	2.8 (wt. avg.)	47	x 0.149 =	7.00
Information System Deficiencies	3.5 (wt. avg.)	58	x 0.115 =	6.67

Hazard Index: 46.36

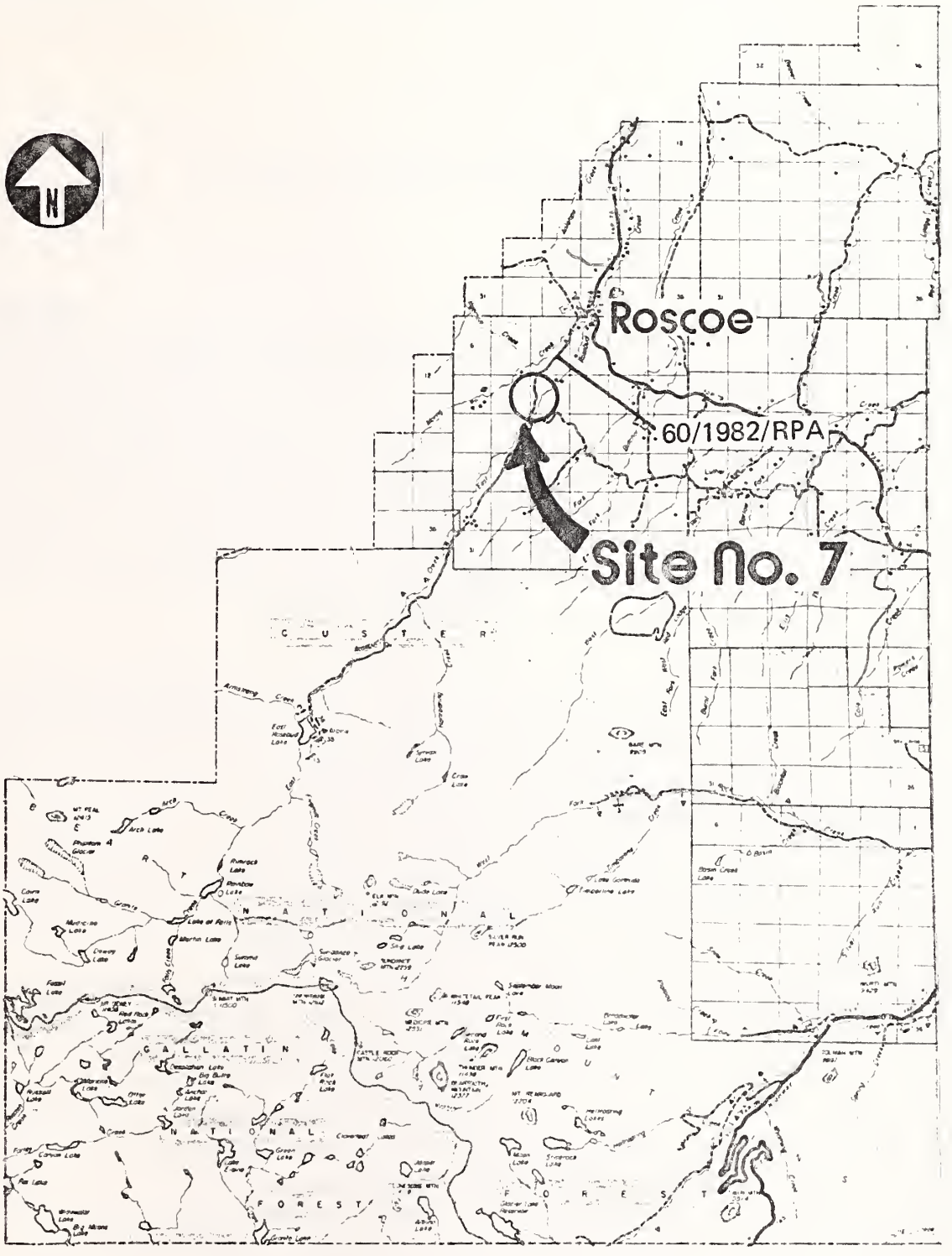
Cost of Recommended Improvements: $1,158

Cost Factor: 92

Priority Index = Hazard Index x .75 + Cost Factor x .25

46.36 x .75 + 92 x .25 = 57.77

SITE 7



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
EAST ROSEBUD ROAD

Figure No.
7-A
Carbon Co

SITE #7

EAST ROSEBUD RIVER ROAD

A. Location

Site #7 is located approximately 2.4 miles southwest of Roscoe in the extreme western portion of Carbon County. This section of the East Rosebud River Road consists of a series of sharp curves through rolling terrain. East Rosebud River Road provides access to several large cattle ranching operations in the area as well as East Rosebud Lake in the Custer National Forest. A significant number of seasonal residences exist at East Rosebud Lake which generate traffic primarily in the summer. Figure 7A depicts the location of this site and the traffic count data collected for East Rosebud River Road.

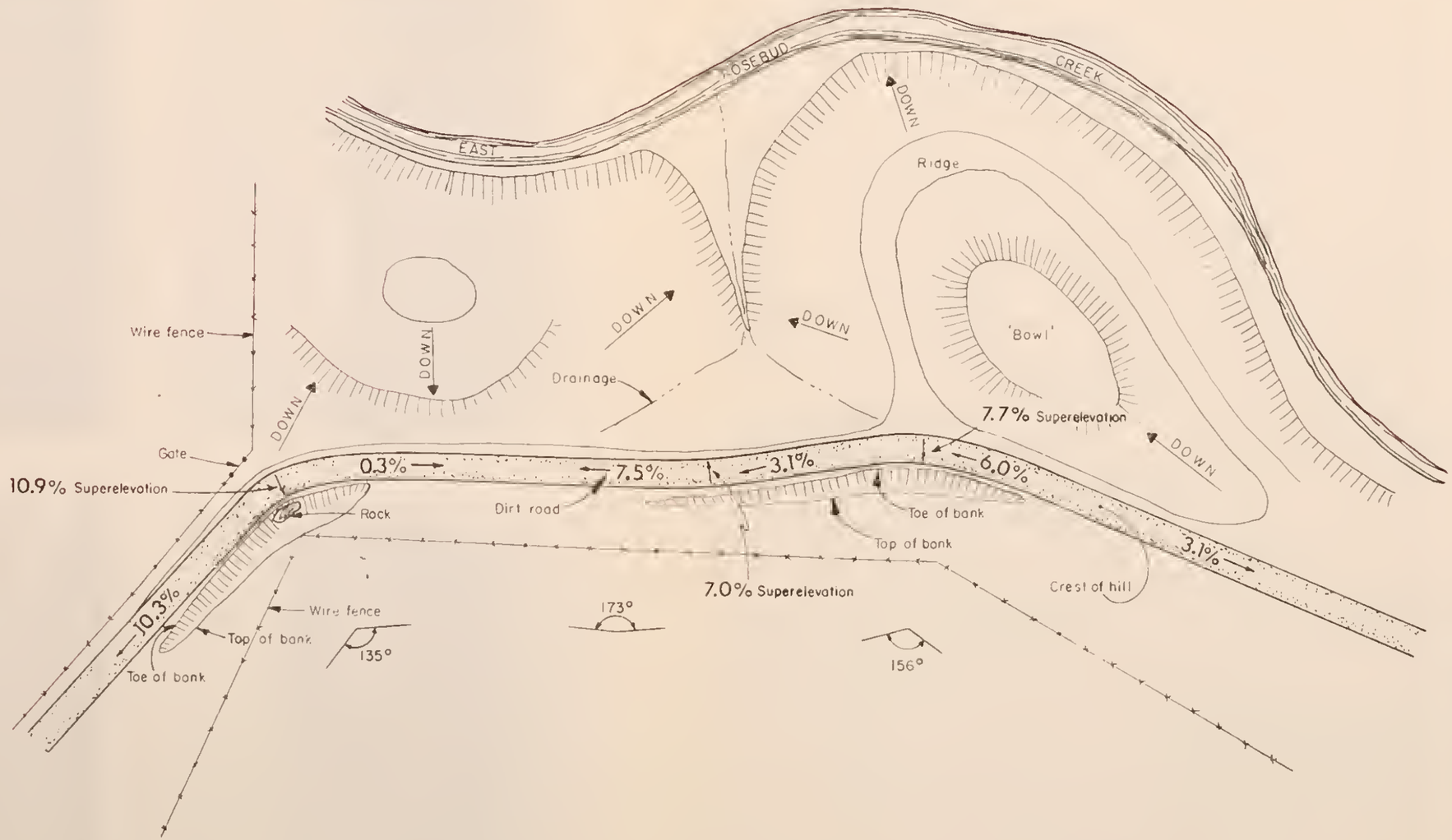
B. Existing Conditions

East Rosebud River Road at Site #7 is a gravel-surfaced roadway that is typically 20 feet wide. Grades within the site range from 0.3 percent to a maximum of 10.3 percent. Superelevation in the curves in the site are effective and range from 7.0 to 10.3 percent. The roadway surface through the site is in generally good condition. Obstructions are generally more than ten feet away from the edge of the roadway, except in the first sharp turn in the eastern portion of the site. At this point, a large boulder is located less than ten feet from the roadway edge. The combination of curves, grades, and the obstruction at this point limits sight distance to approximately 140 feet. No signing presently exists within the site. The significant features of Site #7 are depicted in the site sketch (Figure 7B) and site photographs (Plate 7) which accompany this analysis.

Traffic data on East Rosebud River Road was collected by Robert Peccia & Associates during November, 1982. Machine counts of 24-hour traffic volumes were used to determine average daily traffic (ADT) at this site. Based on this data, the ADT for this location on East Rosebud River Road was determined to be 60 vehicles. Because of the numerous summer homes in the East Rosebud Lake area, traffic volumes are expected to be significantly higher during the summer months.

C. Accident History

One accident was reported at this location on the East Rosebud River Road during the four-year accident study period. In addition, however, four other accidents occurred in or near the site during recent years that were not included in the study period. The majority of these accidents involved single vehicles that left the roadway and struck roadside objects. One of the accidents was a head-on collision in a blind corner in the site that resulted in injuries to four persons. Most of these accidents occurred during the day



EXISTING CONDITIONS

EAST ROSEBUD ROAD

Site No. 7

Figure No.
7-B
Carbon Co.

Existing Site Conditions

View of the sharp curve on the north approach to the site. The change in roadway alignment and grade at this point limit sight distance to 140 feet.

View of the roadway near the southern end of the site. Note the steep areas adjacent to the edge of the road.

View of the East Rosebud River Road in Site 7. Note the rolling terrain typical to this portion of Carbon County.

Typical sight distance limitation caused by abrupt changes in grade on the roadway.

Plate 7

SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

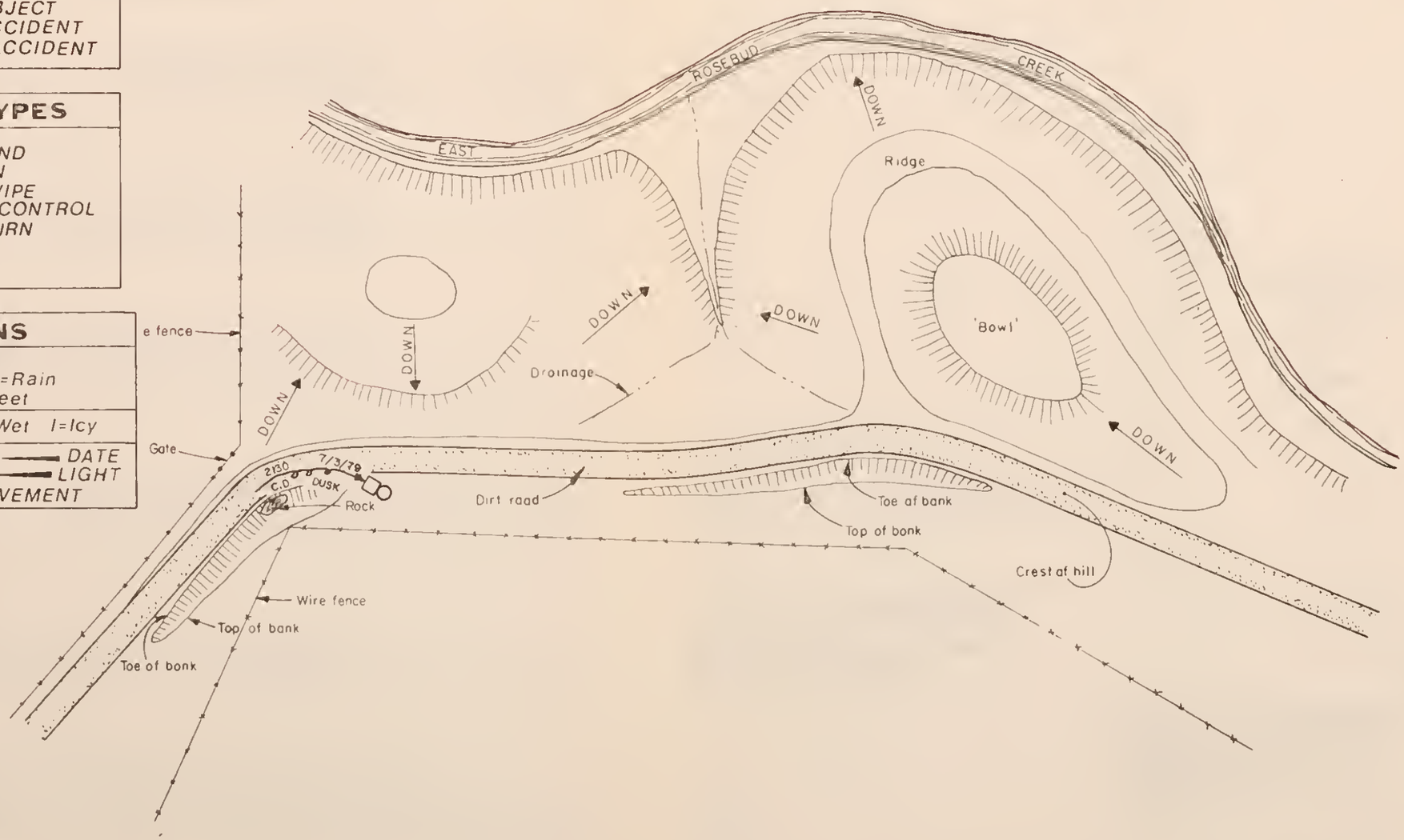
- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME 1400 7-05-75 DATE
WEATHER C. D DAY LIGHT
PAVEMENT



COLLISION DIAGRAM

EAST ROSEBUD ROAD

Site No. 7.0

Figure No. 7-C

Carbon Co.

ACCIDENT DATA

East Rosebud River Road

SITE NUMBER 7 ACCIDENT PERIOD 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
	1		

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
		1				

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						1					

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
																				1			

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
			1

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
1				

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
1			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			1						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
			1					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury		1		
Fatality				
Property Dam. Only				

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

under clear and dry weather and road conditions. The accident that occurred during the study period was a single-vehicle accident in which the driver lost control of the vehicle, which left the roadway and struck a large rock adjacent to the road. The major contributing circumstance to this accident was listed as excessive speed; alcohol was also involved. The composite collision diagram for this site is depicted in Figure 7C.

The accident rate for this site is 11.4 accidents per million vehicles entering.

D. Recommendations

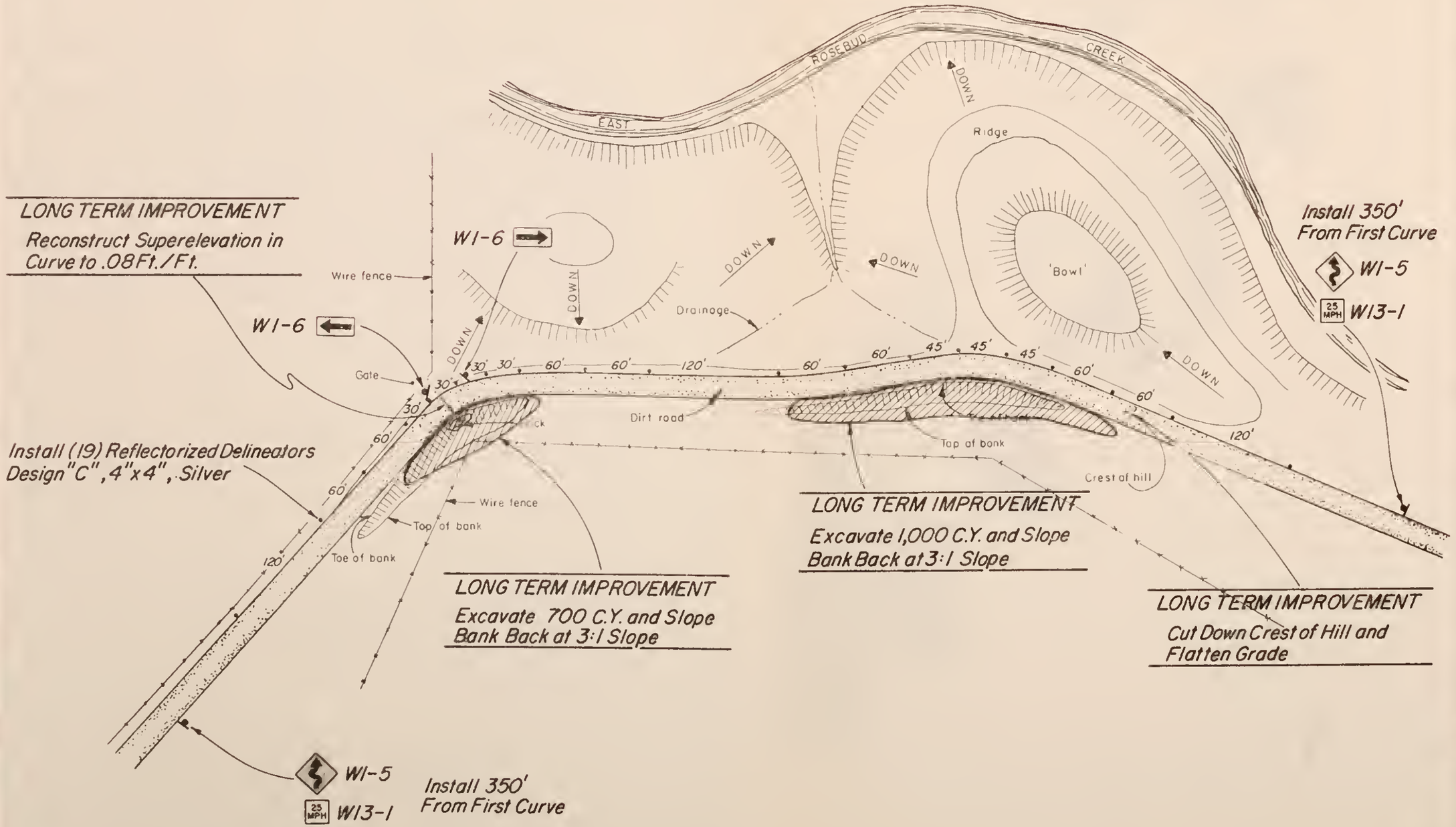
The East Rosebud River Road tends to follow the rolling terrain of the surrounding area. Due to the hills and curves at this site, sight distance is limited to less than 100 feet in some sections. There is no signing to aid motorists in negotiating this site. The short-term improvements outlined below address the need for signing, while the long-term improvements deal with spot road reconstruction necessary to improve the sight distance.

1. Due to the variety of curves and grade changes in this site, it is appropriate to post winding road warning signs (W1-5) on both approaches. These signs should be placed on the tangent approach sections approximately 350 feet before the first curve. Through the use of a ball bank indicator, 25 mph was determined to be the maximum safe speed for this series of curves. Therefore, 25 mph advisory speed plates should accompany the winding road warning signs.

2. To further aid motorists in negotiating this site, a series of reflectorized delineators (Design C, 4" x 4", silver, bi-directional) should be installed on the east side of the road. (Delineator spacing and approximate locations are depicted in Figure 7D.) The spacing varies from 120 feet in the tangent sections to 30 feet in the tight curve at the north end of the site. Note that in the wider curve on the south end of the site, the delineators are spaced 45 feet apart. This spacing will not only guide motorists through the site, but will indicate the severity of the change in alignment.

3. The curve at the north end of the site is a very abrupt change in alignment occurring on the crest of a hill. It is recommended that large directional arrows (W1-6, 48" x 24") be installed in the curve so that they are visible for 500 feet on each approach.

RECOMMENDED IMPROVEMENTS



EAST ROSEBUD ROAD

Site No. 7

Figure No. 7-D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number *7* Date *December, 1982*

Site Description *East Rosebud River Road*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*0.25* acc/yr	*12*	x 0.164 =	*1.97*
Accident Rate	*11.4* acc/MVE	*100*	x 0.225 =	*22.50*
Accident Severity	*10,500* dollars	*64*	x 0.191 =	*12.22*
Volume/Capacity Ratio	*.07*	*22*	x 0.082 =	*1.80*
Sight Distance Ratio	*.53* (wt. avg.)	*97*	x 0.074 =	*7.18*
Driver Expectancy	*4.8* (wt. avg.)	*80*	x 0.149 =	*11.92*
Information System Deficiencies	*5.5* (wt. avg.)	*92*	x 0.115 =	*10.58*

Hazard Index: *68.17*

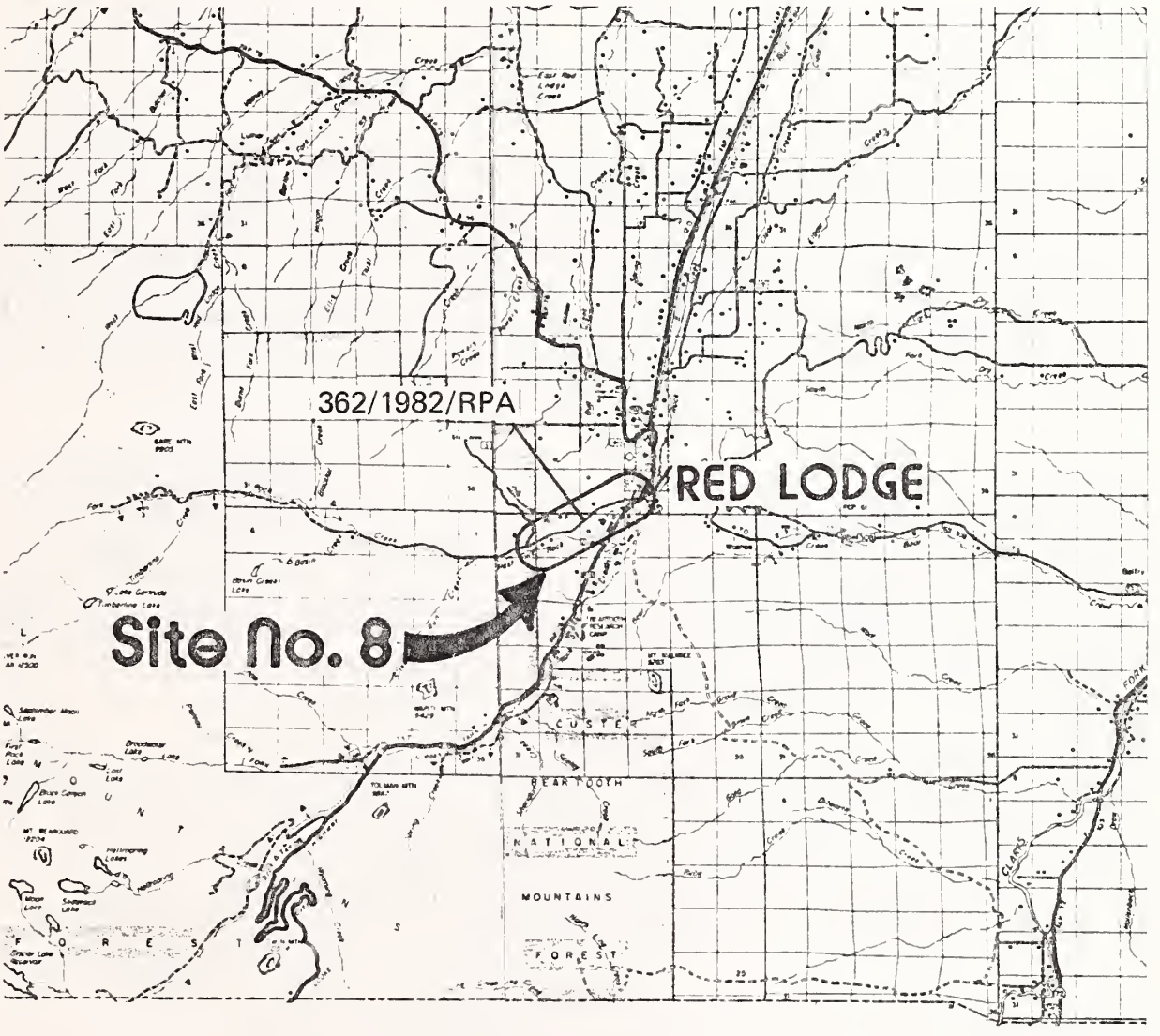
Cost of Recommended Improvements: *$1,028*

Cost Factor: *82*

Priority Index = Hazard Index x .75 + Cost Factor x .25

68.17 x .75 + *82* x .25 = *71.63*

SITE 8



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
WEST FORK ROAD

Figure No.
8-A
Carbon Co

SITE #8

WEST FORK ROAD

A. Location

Site #8 consists of a 2.65-mile-long section of the West Fork Road extending southwesterly from the intersection of US 212 (FAP 28) in Red Lodge to the turnoff to the Red Lodge Mountain Ski Area. The West Fork Road also provides access to several residential subdivisions located west of Red Lodge and to recreation sites located within the Custer National Forest. The location of this site and the available traffic count data are presented in Figure 8A.

B. Existing Conditions

The asphalt pavement surface of the West Fork Road is generally 24 to 25 feet wide, and is striped to delineate two 12-foot driving lanes and two narrow shoulders. The pavement surface is in generally good condition except for an area approximately .9 miles west of Red Lodge, which is severely cracked and shows evidence of a frost-heaving problem. Road grades over much of the site range from 2 to 4 percent; however, the hill located approximately .4 miles west of the intersection with US 212 in Red Lodge has a 7 percent grade, the maximum grade within this section of the West Fork Road. Sight distance is somewhat limited in this same area due to the road grades, curves, and adjacent vegetation. In addition, the entire length of the West Fork Road has steep areas adjacent to the roadway edges that present a hazardous situation to unwary motorists, especially during winter driving conditions.

Most of the signing at this site is located within the initial .25 miles of roadway west of the US 212 intersection in Red Lodge. This signing is primarily intended to guide eastbound motorists through a rather sharp curve near the intersection. It includes a non-standard "slow" sign mounted on a fence post approximately .25 miles from the intersection; a turn sign (W1-1R) with a 15 mph advisory speed plate located .2 miles west of the intersection; a "stop ahead" sign (W3-1) located .15 miles west of the intersection; a large arrow directional sign (W1-6) and chevrons (W1-8) located in the curve; and a stop sign located at the intersection. A non-standard speed limit (40 mph) sign is located near the turnoff for the Red Lodge Mountain Ski Area and intended for eastbound motorists. Existing site conditions are depicted in Plates 8A and 8B.

Traffic data for West Fork Road was collected by Robert Peccia & Associates during November, 1982. Machine counts of 24-hour traffic volumes were used to determine that average daily traffic for the site was 362 vehicles. Traffic volumes on West Fork Road are directly related to usage of the facilities at Red Lodge Mountain. Conversations with local officials and

Existing Site Conditions

View of the West Fork Road near its intersection of US 212 at Red Lodge. Note pavement markings and signing in the curve.

View of the West Fork Road approximately one mile west of Red Lodge. The pavement in this area of the site is severely affected by frost heaving in the winter months.

View of advance signing near the east end of the site.

Roadside vegetation and changes in roadway alignment limit sight distance somewhat in this initial mile of the West Fork Road.

Plate 8A

Existing Site Conditions

View of the terrain typical to the western portion of the site. Road grades range from 2 to 4 percent in this area.

View of the damaged, non-standard speed limit sign near the west end of the site. Note pavement striping and steep areas adjacent to both shoulders of the road.

The West Fork Road serves numerous residential subdivisions located about two miles west of Red Lodge.

View of the sharp turn near the intersection of the West Fork Road and the Red Lodge Mountain Road at the west end of the site.

Plate 8B

representatives of Red Lodge Mountain Ski Area indicate that an additional 800 to 1,000 vehicles per day use the West Fork Road during the ski season.

C. Accident History

A total of fifteen accidents were recorded at this site on the West Fork Road during the 1978-1981 study period. Nine of these accidents resulted in injuries to a total of 23 persons; there were no fatal accidents at this site. Twelve of the accidents involved single vehicles that left the roadway and struck roadside objects. Over 75 percent of the accidents occurred during the winter months, and most took place during the day. Road conditions were most often dry, and the weather was clear; only five accidents occurred during snowy or icy road conditions. It appears that the steep areas adjacent to the roadway are responsible in many instances for pulling vehicles off the road. In half of the reported accidents at this site, excess speed, reckless driving or drinking were listed as major contributing circumstances. Alcohol was involved in five of the sixteen accidents. Locations and pertinent data for each accident during the four-year study period are presented in Figure 8B.

The accident rate for this 2.65-mile-long section of the West Fork Road is 28.4 accidents per million vehicles entering.

D. Recommendations

This section of the West Fork Road has a variety of problems, most of which can be improved through the use of proper signing and delineation. Due to the length of this site, the location of each recommended improvement is referenced by the distance from the intersection of the West Fork Road and US 212. The short-term improvements are listed as follows:

1. At the intersection of US 212 and the West Fork Road, several modifications to the existing signing system should be made. The present stop sign is located 14 feet to the right of the travel lane, and is less than effective at this location. The existing 30" x 30" stop sign should be removed and a new 36" x 36" stop sign (R1-1) installed approximately six feet to the right of the approach driving lane.

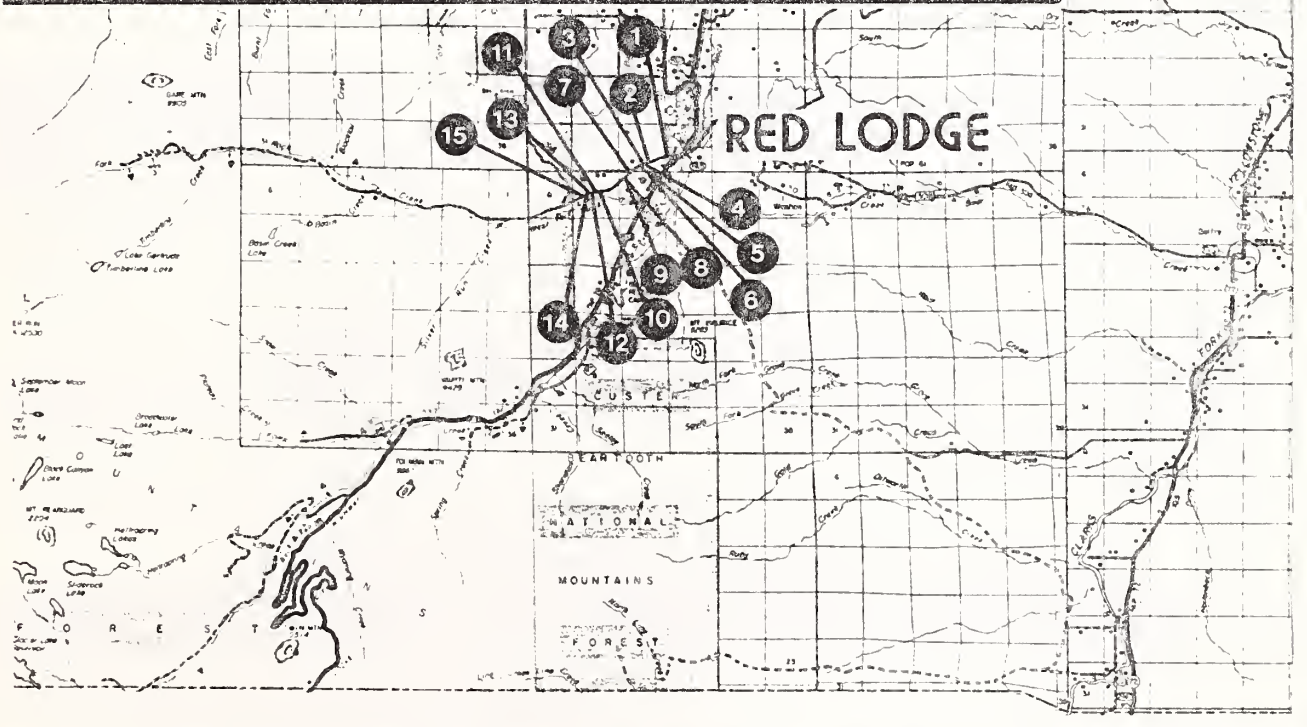
In addition, a large double directional arrow warning sign (W1-7, 48" x 24") should be installed on the southeast side of the intersection. Side road warning signs (W2-2) should also be installed on US 212 approximately 500 feet back from the intersection on both approaches.

2. (0.25 miles from US 212) The non-standard "Slow" sign at this location should be removed.

3. (0.30 miles from US 212) The brush and shrubs on the inside of this curve block view of the road around the bend. This vegetation should be trimmed back to improve sight distance at this location.

4. (0.9 miles from US 212) The sight distance at this location is limited by brush on the inside shoulder of the curve in the road, and this brush

Accident No.	Date	Time	Light Condition	Road Condition	Weather
1	12/31/81	1605	Day	Icy	Clear
2	09/05/80	2330	Night	Dry	Clear
3	03/27/81	0840	Day	Snow	Snow
4	10/10/80	2340	Night	Dry	Clear
5	03/15/81	1340	Day	Dry	Clear
6	11/24/79	1600	Day	Icy	Snow
7	08/05/80	2230	Night	Dry	Clear
8	12/24/78	1730	Night	Icy	Snow
9	12/31/78	1240	Day	Icy	Clear
10	12/20/80	1425	Day	Icy	Clear
11	02/20/80	1610	Day	Dry	Clear
12	05/20/80	1215	Day	Dry	Clear
13	10/18/78	1200	Day	Dry	Clear
14	03/06/80	1000	Day	Dry	Clear
15	10/06/80	1500	Day	Dry	Clear



ACCIDENT LOCATIONS

WEST FORK ROAD

Figure No. 8-B Carbon Co

ACCIDENT DATA

West Fork Road

SITE NUMBER 8 **ACCIDENT PERIOD** 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
3	1	8	3

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
3	1	2	1	3	2	3

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	1	3		1			1	1	3	1	4

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
							1		1		3	1	1	1	3	1					1	2	

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
11	4		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
10		1	4	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
12		3	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
1			11			1	1	1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
7	1	2	4					1

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury	1	1	5	2
Fatality				
Property Dam. Only	2		3	1

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

5

should be removed. This curve is the first of several mild curves going down the hill toward US 212. A winding road warning sign (W1-5) should be placed 500 feet before the first curve to alert drivers to the road configuration.

5. (1.05 miles from US 212) The Palisades Campground Road intersects the West Fork Road at this location. A stop sign (R1-1, 36" x 36") should be installed at the intersection on the side road approach. In addition, side road warning signs (W2-3) should be placed 500 feet before the first curve.

6. (1.15 through 1.25 miles from US 212) The reverse curves at this location should be signed and identified by placing reverse turn warning signs (W1-3) 500 feet back from the beginning of the curves on both approaches. A vehicle equipped with a ball bank indicator was used to determine that 30 mph is the maximum safe speed for these curves. Therefore, 30 mph advisory speed plates should accompany the warning signs. In addition, the alignment of the curves should be identified by installing a series of reflectorized delineators (Design C, 4" x 4", silver, bi-directional) on the outside of the curves. These reflectors should be spaced 60 feet apart in the curves and 125 feet apart on the tangent sections, which will tend to lead motorists into and through the curves. A total of sixteen reflectors will be necessary to adequately identify these curves.

7. (1.55 miles from US 212) An access to a residential development on the south side of the road intersects the West Fork Road at this location, and there is no form of traffic control at present at this intersection. A stop sign (R1-1, 36" x 36") should be installed on the south approach from the subdivision to regulate traffic movement at this location.

8. (1.65 miles from US 212) The curve at this location should be identified through the use of warning signs and delineators. Curve warning signs (W1-2) should be installed 500 feet back from the curve on both approaches. In addition, a series of reflectorized delineators (Design C, 4" x 4", silver, bi-directional) should be installed around the outside of the curve. These reflectors should be spaced 75 feet apart in the curve and 150 feet apart on the approaches. A total of eight delineators will be required.

9. (2.05 miles from US 212) A stop sign (R1-1) should be installed at the Wapiti Valley turnoff at this location. This stop sign should be 36" x 36", and should be installed on the side road approach to this intersection.

10. (2.3 miles from US 212) The existing 40 mph speed limit sign is undersized and has been damaged. It should be removed and replaced with a standard sized (24" x 30") 40 mph speed limit sign (R2-1).

11. (2.4 miles from US 212) The trees on the south side of the road at this location should be removed. At present, approximately 30 six-inch trees limit the sight distance.

12. (2.65 miles from US 212) At this location, the West Fork Road curves abruptly to the north and leads uphill to the Red Lodge ski area. A ball bank indicator was used to determine that the maximum safe speed for this curve is 20 mph. Therefore, turn warning signs (R1-1) with 20 mph advisory speed plates (W13-1) should be installed. These signs should be located 500 feet in advance of the curve on both approaches.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1	ea	Remove Existing Stop Sign	$35	$ 35
4	ea	Install Stop Sign (R1-1, 36" x 36")	$130	520
1	ea	Install Large Double Directional Arrow Sign (W1-7)	$163	163
2	ea	Install Side Road Warning Sign (W2-2)	$130	260
1	ea	Remove Slow Sign	$35	35
-	Lump Sum	Trim Brush and Shrubs	-	250
1	ea	Install Winding Road Warning Sign (W1-5)	$130	130
2	ea	Install Side Road Warning Sign (W2-3)	$130	260
2	ea	Install Reverse Turn Warning Sign (W1-3) with 30 mph Advisory Speed Plate	$180	360
24	ea	Install Reflectorized Delineators (Design C, 4" x 4", silver, bi-directional)	$18	432
2	ea	Install Curve Warning Signs (W1-2)	$130	260
1	ea	Remove Existing 40 mph Speed Limit Sign	$35	35

Quantity	Unit	Item Description	Unit Price	Total Price
1	ea	Install 40 mph Speed Limit Limit Sign (R2-1, 24" x 30")	$130	$130
-	Lump Sum	Cut and Remove 30 Six-Inch Diameter Trees	-	500
2	ea	Install Turn Warning Signs (W1-1) with 20 mph Advisory Speed Plates	$180	360
Total Cost:				$3,730

Benefit/Cost Ratio: 6.7

Long-Term Improvements

The short-term improvements outlined above adequately address all of the problems at this site; therefore, no long-term improvements are recommended.

DETERMINATION OF HAZARD INDEX

Site Number *8* Date *December, 1982*

Site Description *West Fork Road*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*3.75* acc/yr	*50*	x 0.164 =	*8.20*
Accident Rate	*28.4* acc/MVE	*100*	x 0.225 =	*22.50*
Accident Severity	*12,253* dollars	*69*	x 0.191 =	*13.18*
Volume/Capacity Ratio	*.21*	*38*	x 0.082 =	*3.12*
Sight Distance Ratio	*.79* (wt. avg.)	*54*	x 0.074 =	*4.00*
Driver Expectancy	*2.8* (wt. avg.)	*47*	x 0.149 =	*7.00*
Information System Deficiencies	*4.3* (wt. avg.)	*72*	x 0.115 =	*8.28*

Hazard Index: *66.28*

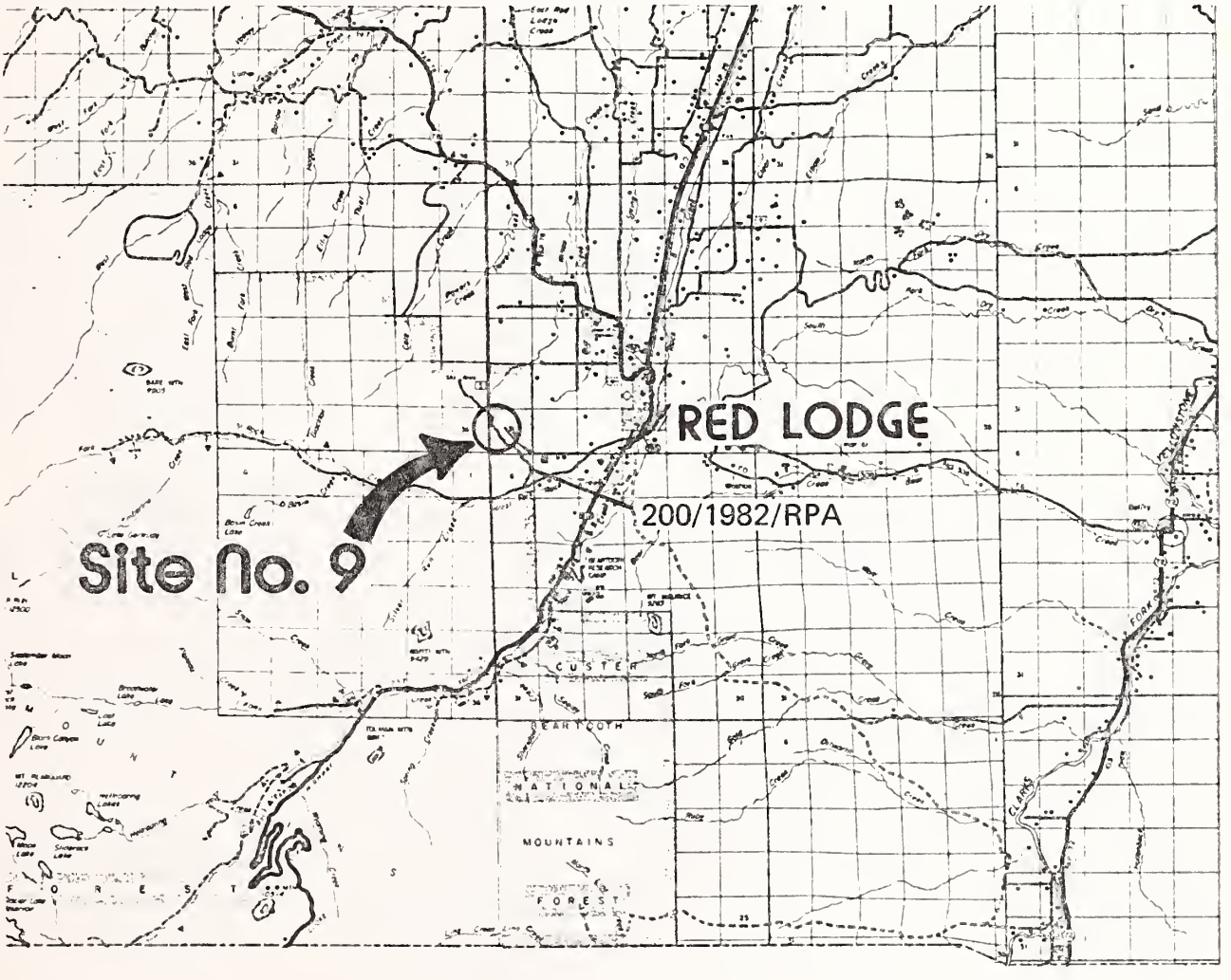
Cost of Recommended Improvements: *$3,730*

Cost Factor: *88*

Priority Index = Hazard Index x .75 + Cost Factor x .25

66.28 x .75 + *88* x .25 = *71.71*

SITE 9



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
LOWER RED LODGE MOUNTAIN

Figure No.
9-A
CarbonCo

SITE #9

LOWER RED LODGE MOUNTAIN ROAD

A. Location

Site #9 is located on the Red Lodge Mountain Road approximately .85 miles north of its intersection with the West Fork Road. The site, which is situated in mountainous terrain west of Red Lodge, consists of a series of reverse turns on the road that provides access to the Red Lodge Mountain Ski Area. This route is primarily used during the winter months by motorists traveling to and from the ski area. The location of this site and available traffic count data are presented in Figure 9A.

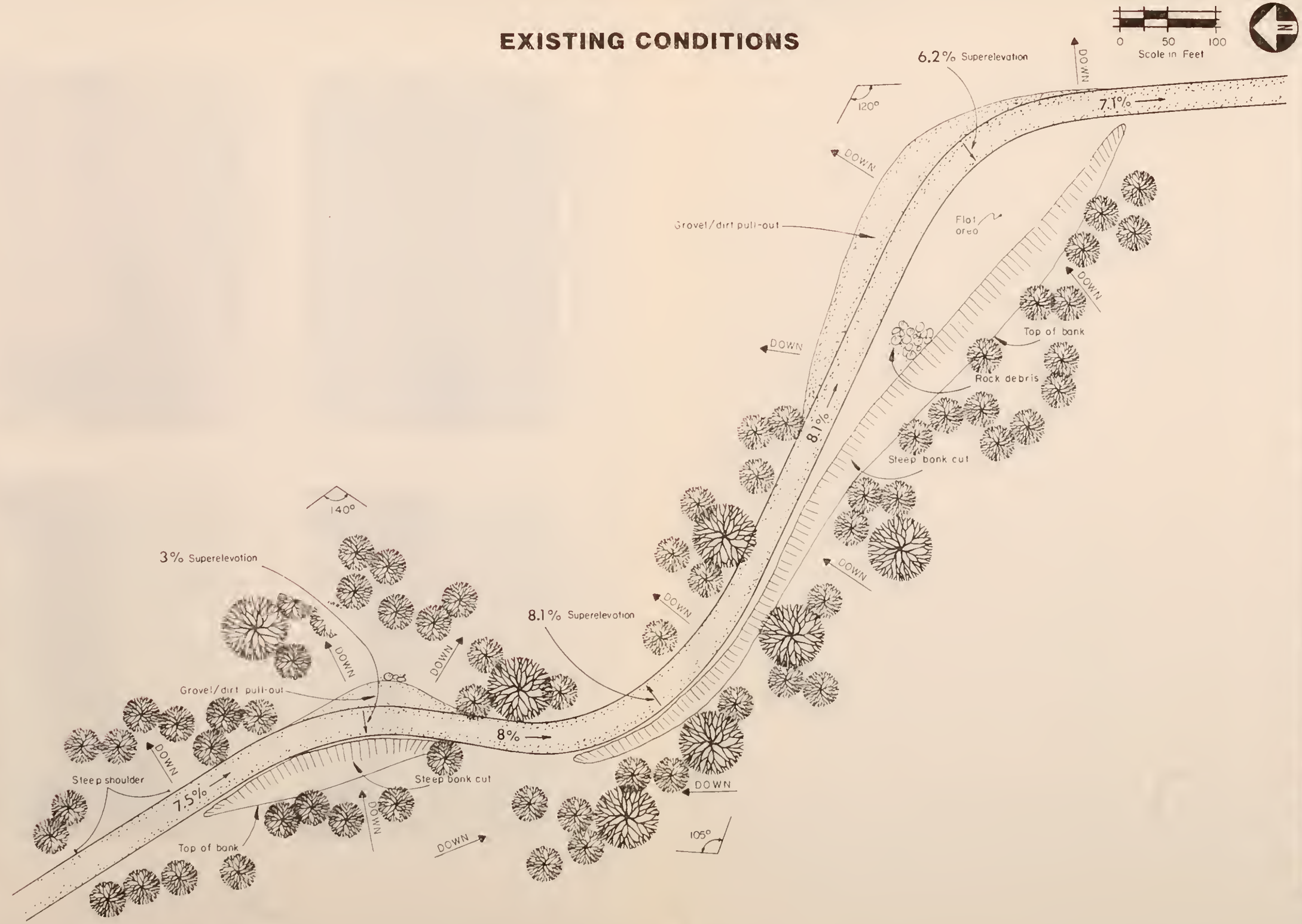
B. Existing Conditions

The Red Lodge Mountain Road at Site #9 is a gravel-surfaced roadway that varies in width from 30 to 45 feet. The roadway, which has been improved in recent years, has wide shoulders for the storage of plowed snow and has vehicle turnouts in numerous locations. Road grades through the site range from a minimum of 7.1 to a maximum of 8.1 percent. Superelevations through the curves at the site are 3.0 percent in the northernmost curve, 8.1 percent in the middle curve, and 6.2 percent through the southernmost curve. Sight distance is limited to 225 feet by the mountainous terrain and the roadside vegetation. The road surface throughout the entire site is in good condition, and Carbon County is currently in the process of resurfacing the entire roadway with gravel. This work has been progressing during the summer and early fall months, and at the time of the inspection, the resurfacing appeared to be approximately half-completed. Winter maintenance and snow removal on the Red Lodge Mountain Road is accomplished through a cooperative agreement between Carbon County and Red Lodge Mountain personnel. Carbon County provides maintenance equipment (a patrol and a sand truck) and Red Lodge Mountain provides equipment operators.

No signing presently exists on the Red Lodge Mountain Road due to the extensive reconstruction activities that took place several years ago. Apparently, the road had been signed before this reconstruction. The existing conditions at Site #9 are depicted in the site sketch (Figure 9B) and site photographs (Plate 9) which accompany this analysis.

Traffic data for the Red Lodge Mountain Road was obtained through conversations with Red Lodge Mountain personnel. Although no actual traffic counts are available for the roadway, the numbers of skiers and the number of cars parked at the ski area were tallied. Based on this data, the annual average daily traffic is anticipated to be 200 vehicles. Traffic may exceed 1,500 vehicles per day during several peak weekends during the ski season.

EXISTING CONDITIONS



LOWER RED LODGE MOUNTAIN ROAD

Site No. 9

Figure No. 9-B

Carbon Co.

Existing Site Conditions

View of the initial curve in the northern portion of the site. Changes in roadway alignment and roadside vegetation limit sight distance to 225 feet in this location.

View of the Red Lodge Mountain Road near the southern end of the site.

View of the curve in the northern portion of the site. Note the pullout area to the right, which is used primarily for emergency stopping and snow removal purposes.

View of the reverse curve located at the southern end of the site. Areas on the downhill side of the roadway are quite steep.

Plate 9

C. Accident History

A total of four accidents were recorded at this location on Red Lodge Mountain Road during the four-year study period. Two of these accidents resulted in injuries to a total of three persons. Three of the four accidents occurred during the winter and involved persons heading to or from the ski area. Three of the accidents were two-car collisions, and the remaining accident involved a single vehicle that left the roadway and rolled several times. Three of the accidents occurred during the daylight hours during clear weather conditions; however, road conditions were icy during three of the four reported accidents. Excess speed for road conditions was listed as the major contributing circumstance in three of the accidents; alcohol was involved in one accident. The composite collision diagram for Site #9 is depicted in Figure 9C.

The accident rate for this site is 13.7 accidents per million vehicles entering.

D. Recommendations

Road conditions during the winter months at Site #9 present the greatest hazard to motorists. Fortunately, Carbon County has a good snow removal and sanding program already in use. Possible improvements along this stretch of road are somewhat limited due to the heavy buildup of snow along the edge of the travelway as a result of the plowing operations. Standard delineation techniques would not be effective at this site because of the high snow berms, and would also present maintenance problems. Therefore, the short-term improvements listed below concentrate on the lack of advance signing and sight distance at this site.

1. At present, there is no signing at this site. The sharp curves, combined with icy or snow-packed road conditions, present serious problems to motorists. Through the use of a ball bank indicator, it was determined that 15 mph is the maximum safe speed for these curves. It is therefore recommended that winding road warning signs (W1-5) with 15 mph advisory speed plates (W13-1) be installed 350 feet before the first curve on both approaches.

2. Sight distance is limited by the trees on the inside of the curve in the middle of this site. Approximately 20 six-inch-diameter trees that line the road in this curve should be removed. This improvement will increase sight distance and give motorists greater advance notice of possible problems ahead. Motorists will therefore have more time to react, which is important since the icy road conditions often found at this site require longer stopping distances.

3. The superelevation of the northernmost curve at this site is only 3 percent, which is too flat for the sharp change in alignment. This curve should be reconstructed to provide a 6 percent superelevation.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
2	ea	Install Winding Road Warning Signs (W1-5) with 15 mph Advisory Speed Plates (W13-1)	$180	$360
-	Lump Sum	Cut and Remove 20 Six-Inch Diameter Trees	-	400
-	Lump Sum	Reconstruct Superelevation in Northernmost Curve	-	500
Total Cost:				$1,260

Benefit/Cost Ratio: 4.2

Long-Term Improvements

The general conditions of the road to Red Lodge Mountain are fairly uniform. The road is steep with many gentle curves, and most of the curves have flat "run out" areas provided on the outside shoulders. During the winter, the road is lined with high snow berms along both sides which tend to narrow the available road width. It is recommended that a series of three-inch diameter wooden guide poles be installed along the edge of the road. These poles should project ten feet out of the ground, and should have 3 four-inch-wide reflectorized silver bands spaced one foot apart on the upper ends of the poles. These tall guide poles should be placed on the edge of the roadway on the downhill side. In this way, maintenance crews will be able to see where the shoulder drops off, and will be able to plow a wider travelway. These reflectors will project above the snow berms and delineate the road alignment. The poles should be installed every 150 feet along the entire length of the Red Lodge Mountain Road.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Install Reflectorized Wooden Poles, 13 ft. long (approx. 125 poles required)	-	$12,500

COLLISION DIAGRAM

SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

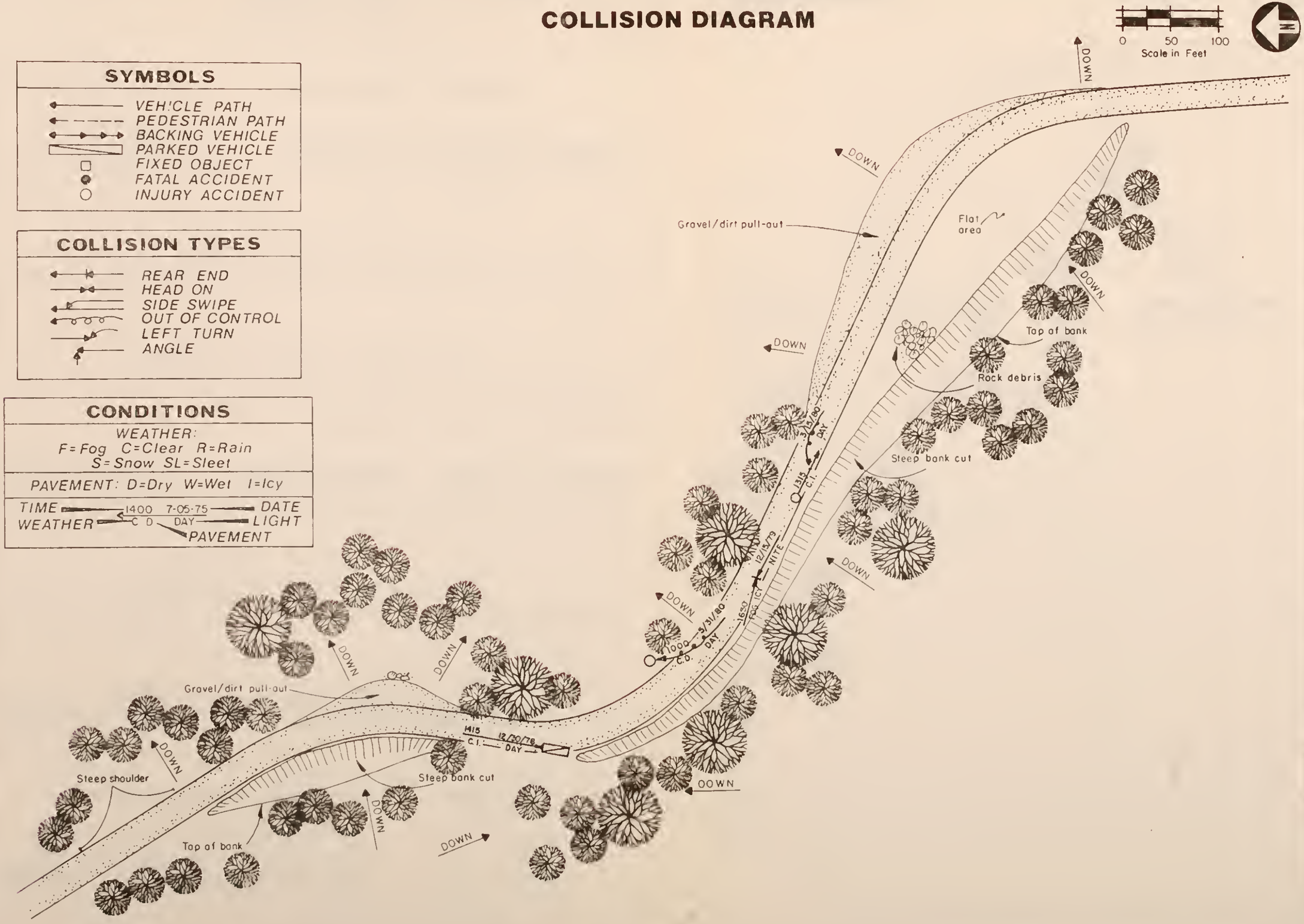
- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME 1400 7-05-75 DATE
WEATHER C D DAY LIGHT
PAVEMENT



LOWER RED LODGE MOUNTAIN ROAD

Site No. 9

Figure No. 9-C

CarbonCo

ACCIDENT DATA

Lower Red Lodge Mountain Road

SITE NUMBER 9 ACCIDENT PERIOD 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
1	1	2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
						4

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		1		1							2

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
									1			1	1		1								

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
3	1		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
1			3	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
3			1

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
1		1	1					1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1			3					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury			2	
Fatality				
Property Dam. Only	1	1		

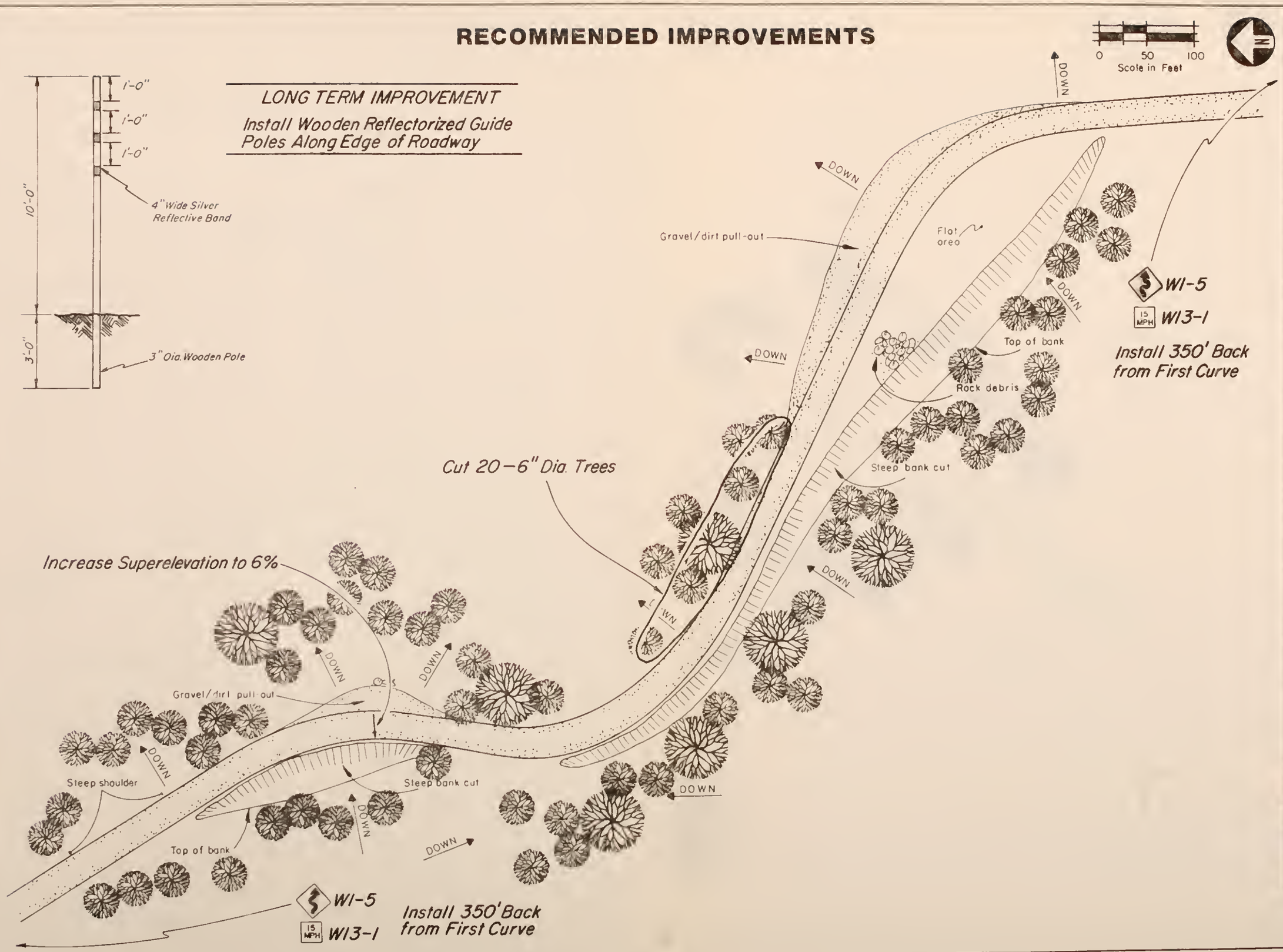
NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

RECOMMENDED IMPROVEMENTS

LONG TERM IMPROVEMENT

Install Wooden Reflectorized Guide Poles Along Edge of Roadway



LOWER RED LODGE MOUNTAIN ROAD

Site No. 9

Figure No. 9-D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number *9* Date *December, 1982*

Site Description *Lower Red Lodge Mountain Road*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*1.0* acc/yr	*26*	x 0.164 =	*4.26*
Accident Rate	*13.7* acc/MVE	*100*	x 0.225 =	*22.50*
Accident Severity	*10,925* dollars	*65*	x 0.191 =	*12.42*
Volume/Capacity Ratio	*.22*	*39*	x 0.082 =	*3.20*
Sight Distance Ratio	*1.04* (wt. avg.)	*28*	x 0.074 =	*2.07*
Driver Expectancy	*3.0* (wt. avg.)	*50*	x 0.149 =	*7.45*
Information System Deficiencies	*6.0* (wt. avg.)	*100*	x 0.115 =	*11.50*

Hazard Index: *63.40*

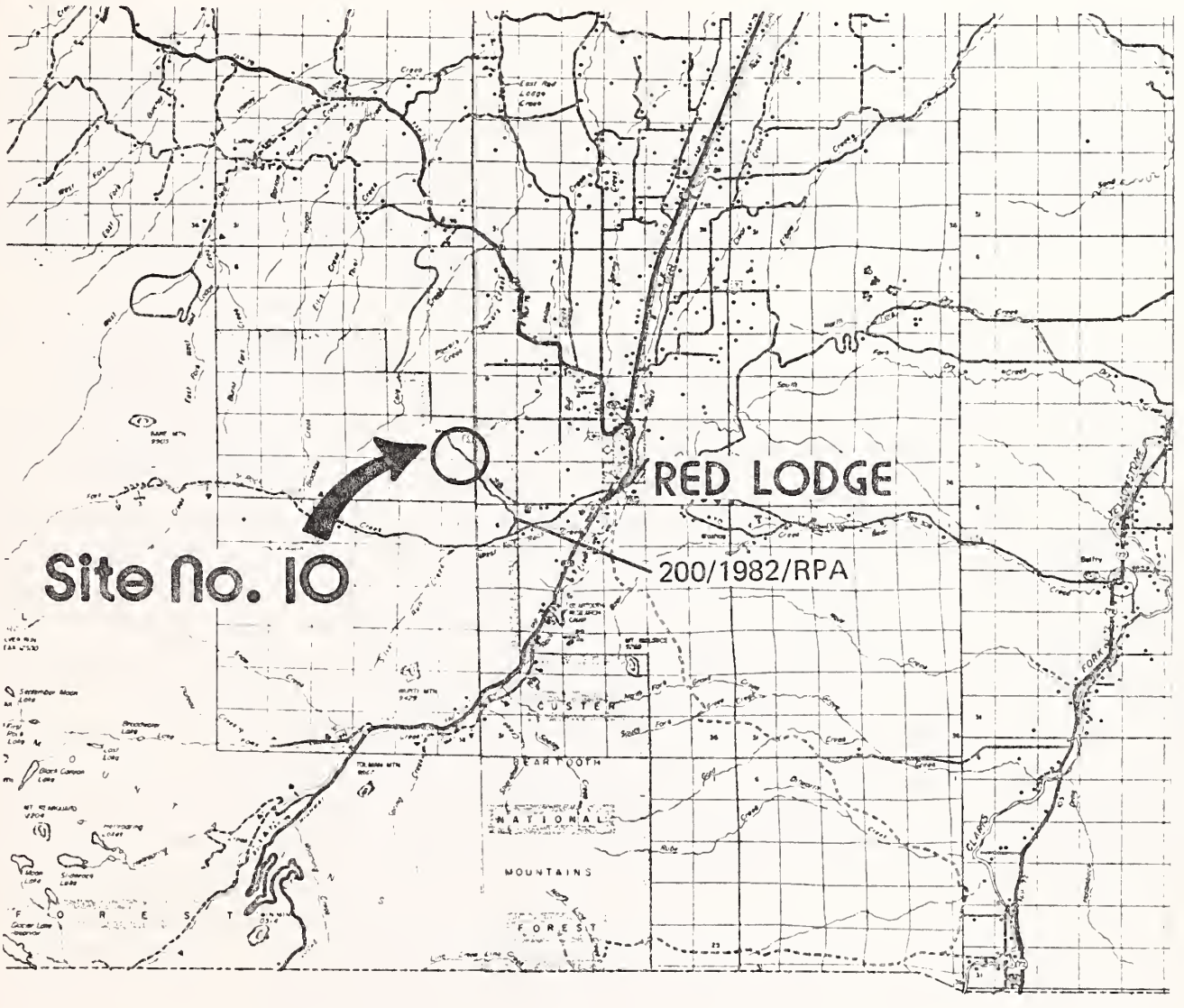
Cost of Recommended Improvements: *$1,260*

Cost Factor: *94*

Priority Index = Hazard Index x .75 + Cost Factor x .25

63.40 x .75 + *94* x .25 = *71.05*

SITE 10



Average Daily Traffic/Year/Source of Count

127/1981/RPA

SITE LOCATION
TRAFFIC COUNTS
UPPER RED LODGE MOUNTAIN

Figure No.
10-A
Carbon Co

SITE #10

UPPER RED LODGE MOUNTAIN ROAD

A. Location

Site #10 is located on Red Lodge Mountain Road approximately 2.0 miles north of its intersection with the West Fork Road. The site is located in mountainous terrain and consists of two broad curves near the Red Lodge Mountain Ski Area. The site location and available traffic count data for the roadway are presented in Figure 10A.

B. Existing Conditions

The Red Lodge Mountain Road at Site #10 is a gravel-surfaced roadway which is typically 30 feet wide. Turnouts located in several spots within the site increase roadway width by as much as 45 feet and provide space necessary for plowed snow or emergency maneuvering. Much of the roadway at this site has extremely steep terrain adjacent to the roadway edge. Approximately 340 feet of guard rail has been installed in one such area within the site. Road grades through the site are relatively constant at 7.0 to 7.4 percent. Superelevations in the two corners at 6.0 percent in the northernmost curve and 7.6 percent in the lower curve. Sight distance is limited to 160 feet in the lower curve due to the roadway alignment change and a steep rock face. This section was reconstruction several years ago, and existing signing was removed to facilitate construction activities. Winter maintenance and snow removal at this site are accomplished through the same cooperative agreement between Carbon County and Red Lodge Mountain personnel discussed for the previous site. The existing conditions at this site are depicted in Figure 10B and in Plate 10.

Based upon data obtained from Red Lodge Mountain personnel, it was determined that average daily traffic on the Red Lodge Mountain Road is 200 vehicles. Peak traffic may approach 1,500 vehicles per day during one or two weekends during the ski season. Traffic at the site can be expected to increase as facilities at Red Lodge Mountain are expanded.

C. Accident History

A total of four accidents were reported at this site during the four-year study period. Three of the four accidents resulted in injuries to a total of four persons. Two of the accidents were single-vehicle accidents; one was a head-on collision; and one was a rear-end collision. All four occurred during the winter months when the road was snowpacked and icy. Three of the four accidents occurred at night. Major contributing circumstances in three of the four accidents were listed as excess speed or drinking. Alcohol was involved in three of the four accidents. The composite collision diagram for Site #10 is depicted in Figure 10C.

The accident rate at this site is 13.7 accidents per million vehicles entering.

EXISTING CONDITIONS

0 50 100
Scale in Feet

N

DOWN
Top of bank
DOWN
Small gravel/dirt surface pull-out both sides
7.2%
DOWN
DOWN
Guardrail
DOWN
6% Superelevation
DOWN
7
Ponding area
90°
DOWN
Drainage
DOWN
90°
DOWN
7.6% Superelevation
DOWN
Gravel/dirt surface pull-out
7.4%
Steep bank cut
DOWN
Top of bank
DOWN
7%
DOWN

UPPER RED LODGE MOUNTAIN ROAD

Site No. 10

Figure No.
10-B

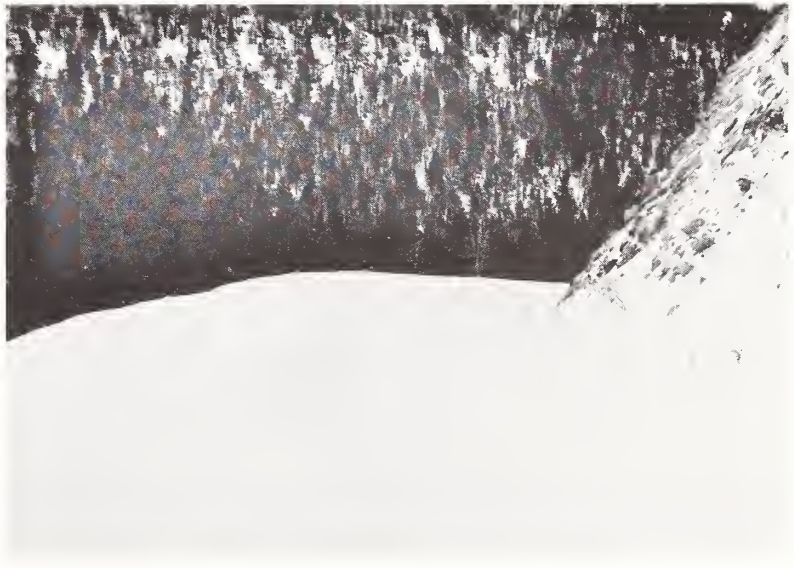
CarbonCo

Existing Site Conditions

View of the curve at the northern end of the site. The face of the fill on the left side of the road is nearly as steep as the right side.

View of the terrain typical to this section of the Red Lodge Mountain Road. The slopes in the steep areas on the downhill side of the road are typically 1:1.

Overall view of the curves at the site. Road grades through the site range from 7 to 7.5 percent.

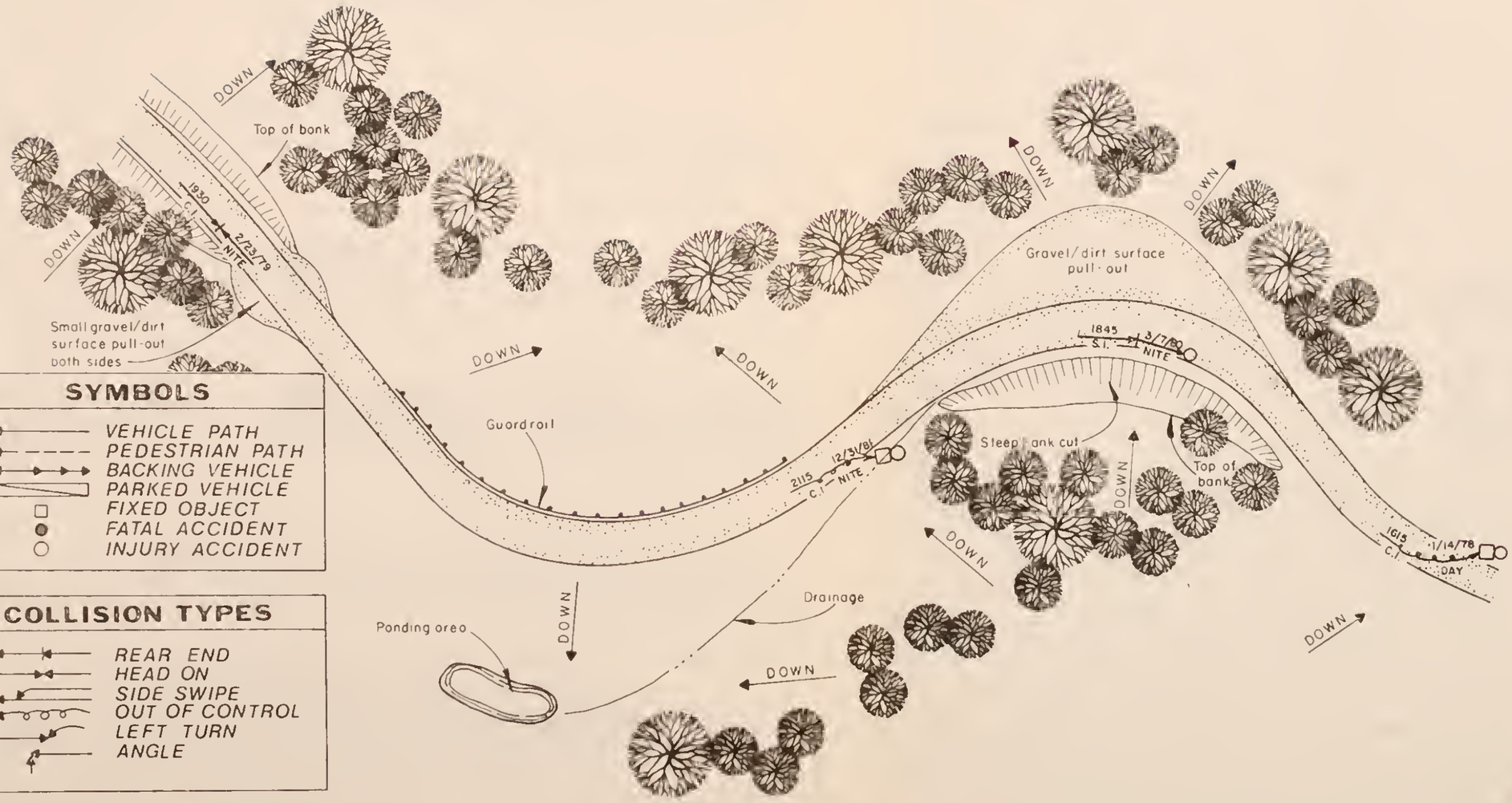


Sight distance at this location of the site is limited to 160 feet by the change in roadway alignment and the rock face adjacent to the roadway.

Plate 10

COLLISION DIAGRAM

0 50 100
Scale in Feet



SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME — 1400 — DATE: 7-05-75
WEATHER — C. D — LIGHT: DAY
PAVEMENT

UPPER RED LODGE MOUNTAIN ROAD

Site No. 10

Figure No. 10-C

CarbonCo

ACCIDENT DATA

Upper Red Lodge Mountain Road

SITE NUMBER 10 **ACCIDENT PERIOD** 1978 – 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
1	1	1	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
				1	2	1

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	1	1									1

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
															1		1	1		1			

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
1	3		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
			4	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
3		1	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
		1	2					1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1	1		2					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury	1		1	1
Fatality				
Property Dam. Only		1		

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

3

D. Recommendations

This section of the Red Lodge Mountain Road is very dangerous due to the sharp curves and steep dropoffs adjacent to the road. The short-term improvements concentrate on adequately signing this section of road, and are listed below.

1. In an effort to give advance warning of the road configuration to motorists, winding road warning signs (W1-5) should be installed at least 350 before the first curve on each approach. A ball bank indicator was used to determine that 15 mph is the maximum safe speed for these curves. It is therefore recommended that 15 mph advisory speed plates be installed with the warning signs.

2. The curve at the south end of the site is very sharp and has limited sight distance due to the embankment on the inside of the curve. In addition, the large gravel pull-out area on the outside of this curve makes it difficult to locate signs to properly delineate the curve. Maintenance requirements also complicate the location of roadside delineation. In an effort clarify the road alignment for motorists, a series of chevron warning signs (W1-8) should be installed on the outside of the curve. However, if these signs were to be placed around the outside edge of the pull-out, motorists would be misled into thinking that the roadway extended all the way out to the outer edge of the pull-out, which it does not. Therefore, these signs should be located as shown in Figure 10D. In this way, motorists will see three chevrons while entering the curve and three on the far side of the gravel pull-out. These chevron warning signs should give motorists advance warning of the curve, identify its location, and delineate the edge of the roadway.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
2	ea	Install Winding Road Warning Signs (W1-5) with 15 mph Advisory Speed Plates (W13-1)	$180	$ 360
14	ea	Install Chevron Warning Signs (W1-8)	$130	1,820
Total Cost:				$2,180

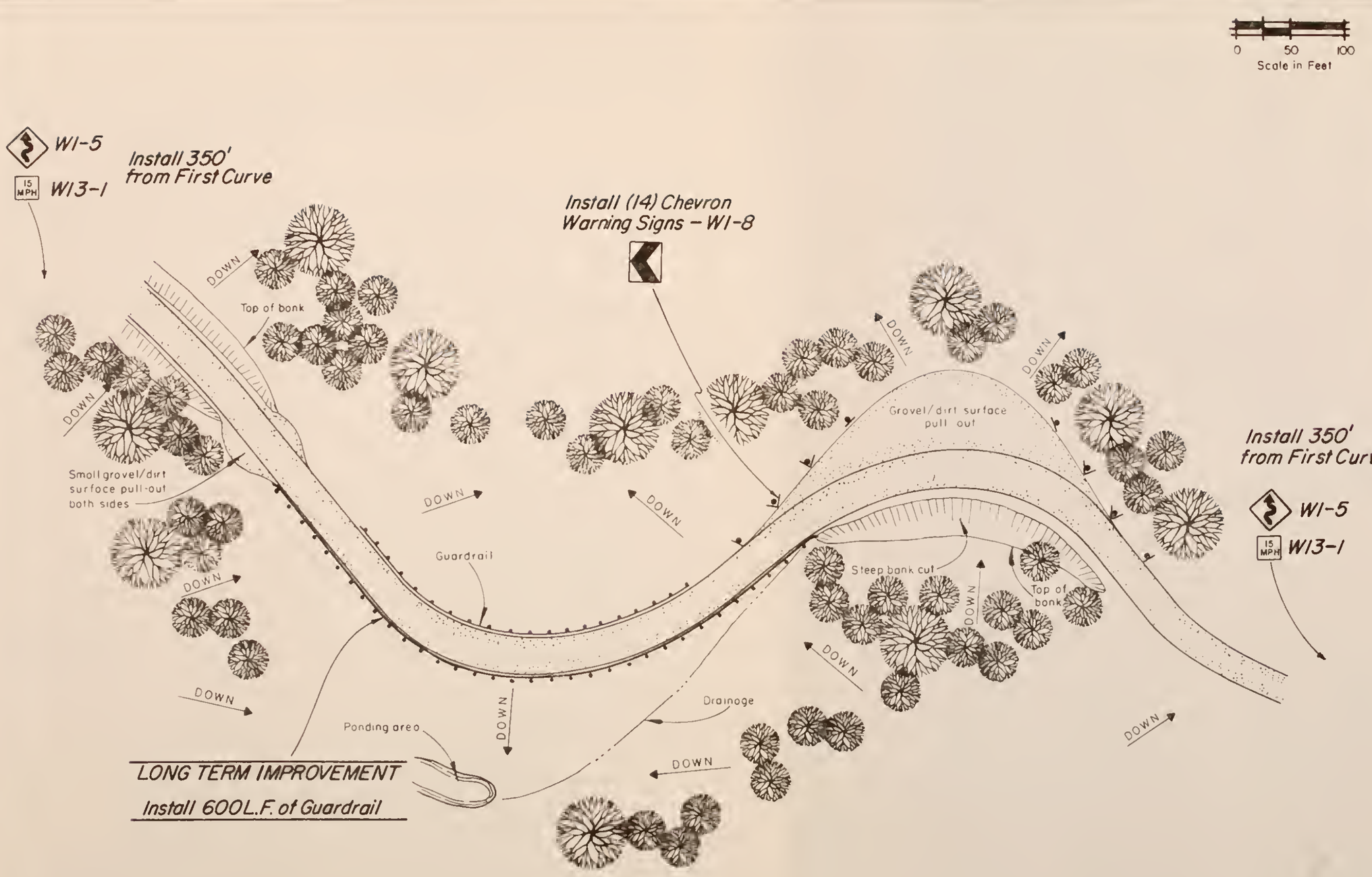
Benefit/Cost Ratio: 4.2

Long-Term Improvements

The steep dropoff adjacent to the outside of the northernmost curve at this site warrants the installation of guard rail. Although the inside of the curve has guard rail at present, it is the outside edge that is of greatest concern. Approximately 600 feet of steel ribbon guard rail should therefore be installed around this curve.

LONG-TERMS IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
600	lf	Install Guard Rail	$9	$5,400



RECOMMENDED IMPROVEMENTS

UPPER RED LODGE MOUNTAIN ROAD

Site No. 10

Figure No. 10-D

Carbon Co.

DETERMINATION OF HAZARD INDEX

Site Number *10* **Date** *December, 1982*

Site Description *Upper Red Lodge Mountain Road*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*1.0* acc/yr	*26*	x 0.164 =	*4.26*
Accident Rate	*13.7* acc/MVE	*100*	x 0.225 =	*22.50*
Accident Severity	*16,100* dollars	*78*	x 0.191 =	*14.90*
Volume/Capacity Ratio	*.22*	*39*	x 0.082 =	*3.20*
Sight Distance Ratio	*.76* (wt. avg.)	*55*	x 0.074 =	*4.07*
Driver Expectancy	*4.0* (wt. avg.)	*67*	x 0.149 =	*9.98*
Information System Deficiencies	*6.0* (wt. avg.)	*100*	x 0.115 =	*11.50*

Hazard Index: *70.41*

Cost of Recommended Improvements: *$2,180*

Cost Factor: *88*

Priority Index = Hazard Index x .75 + Cost Factor x .25

70.41 x .75 + *88* x .25 = *74.81*

CHAPTER V
BIBLIOGRAPHY

BIBLIOGRAPHY

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CHAPTER VI
APPENDIX

DETERMINATION OF HAZARD INDEX

Site Number _____ Date _____

Site Description _____

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	_____ acc/yr	_____	x 0.164 =	_____
Accident Rate	_____ acc/MVE	_____	x 0.225 =	_____
Accident Severity	_____ dollars	_____	x 0.191 =	_____
Volume/Capacity Ratio	_____	_____	x 0.082 =	_____
Sight Distance Ratio	_____ (wt. avg.)	_____	x 0.074 =	_____
Driver Expectancy	_____ (wt. avg.)	_____	x 0.149 =	_____
Information System Deficiencies	_____ (wt. avg.)	_____	x 0.115 =	_____

Hazard Index: _____

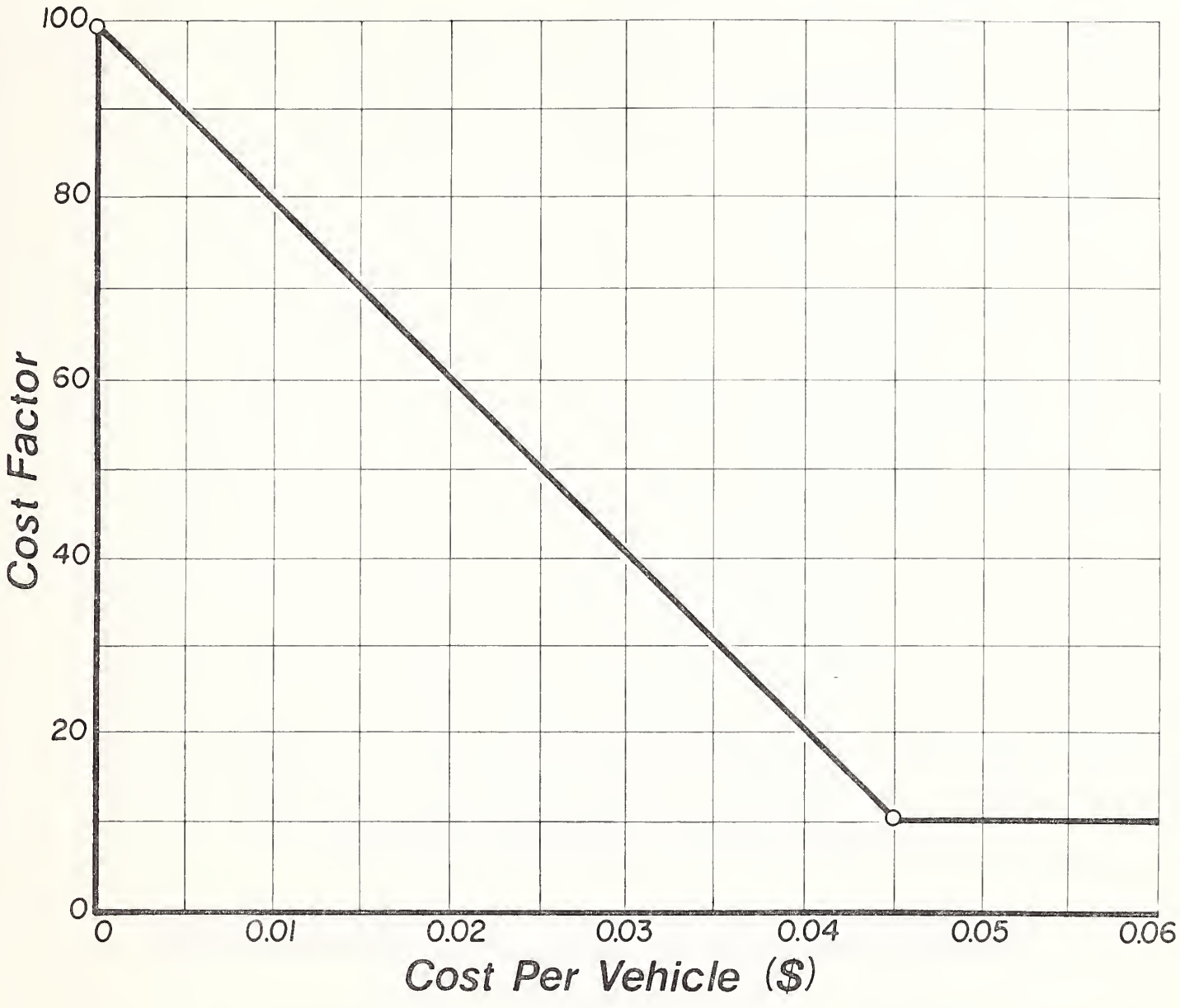
Cost of Recommended Improvements: _____

Cost Factor: _____

Priority Index = Hazard Index x .75 + Cost Factor x .25

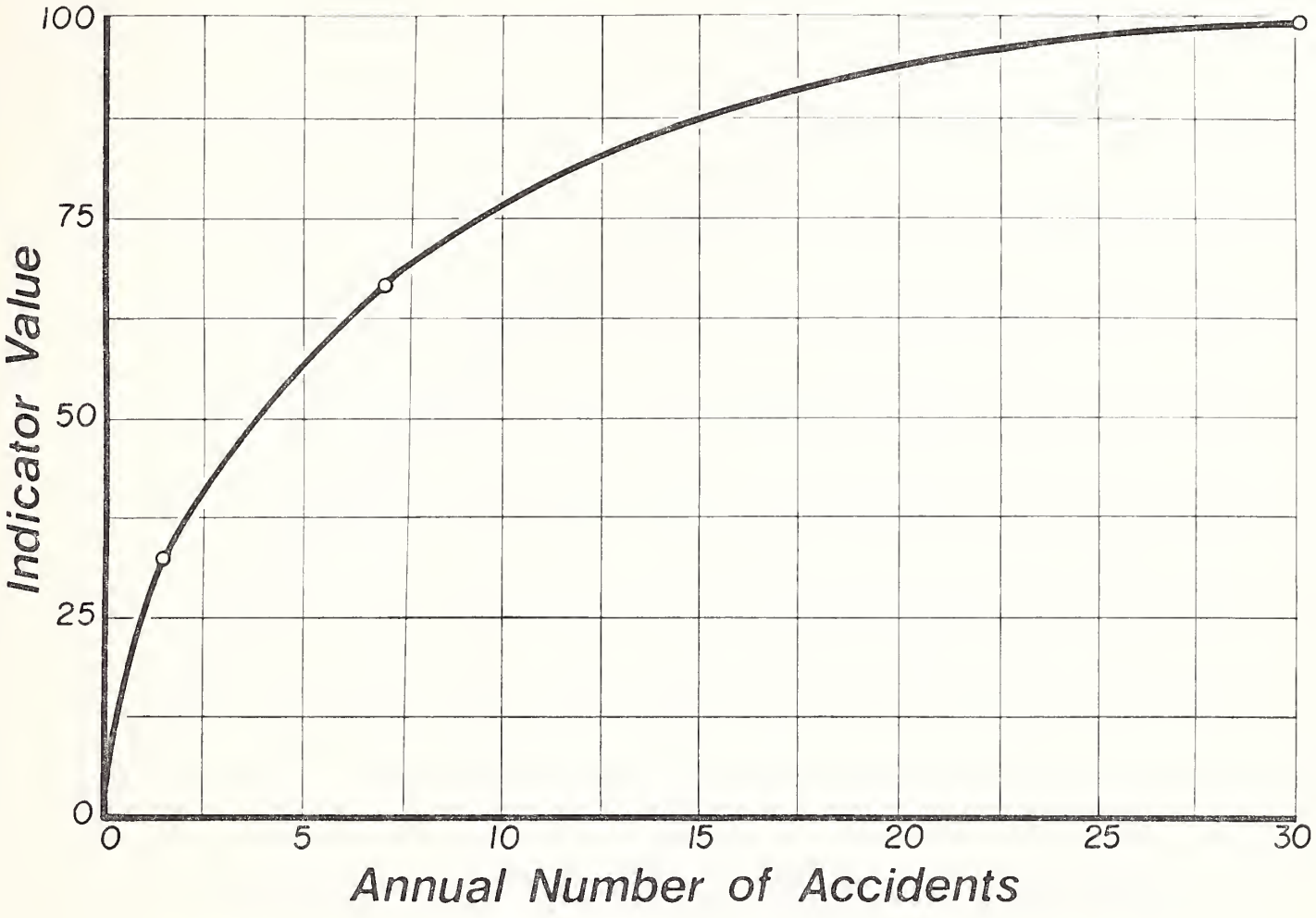
_____ x .75 + _____ x .25 = _____

FIGURE A1



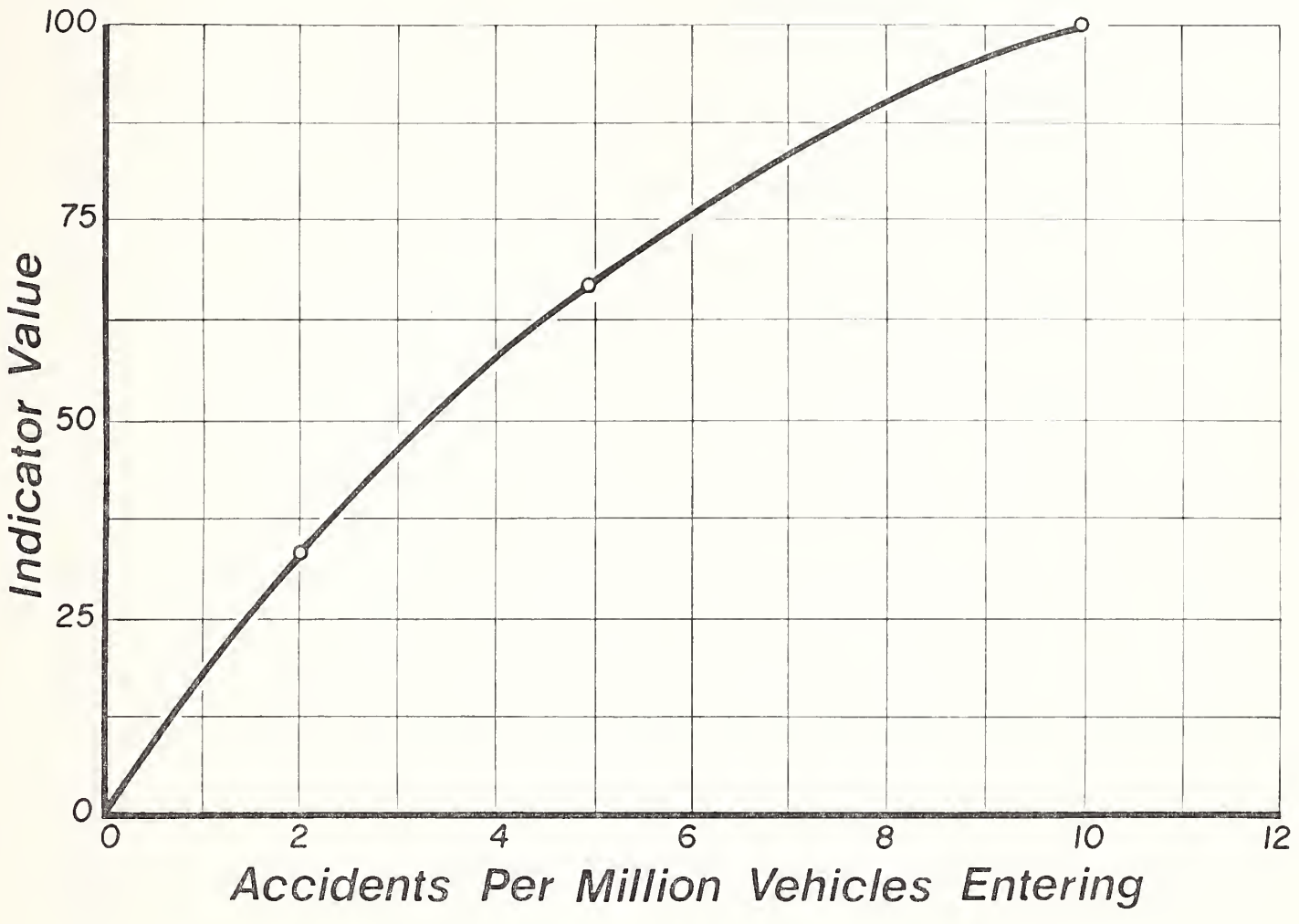
FORM FOR DETERMINATION
OF COST FACTOR

FIGURE A 2



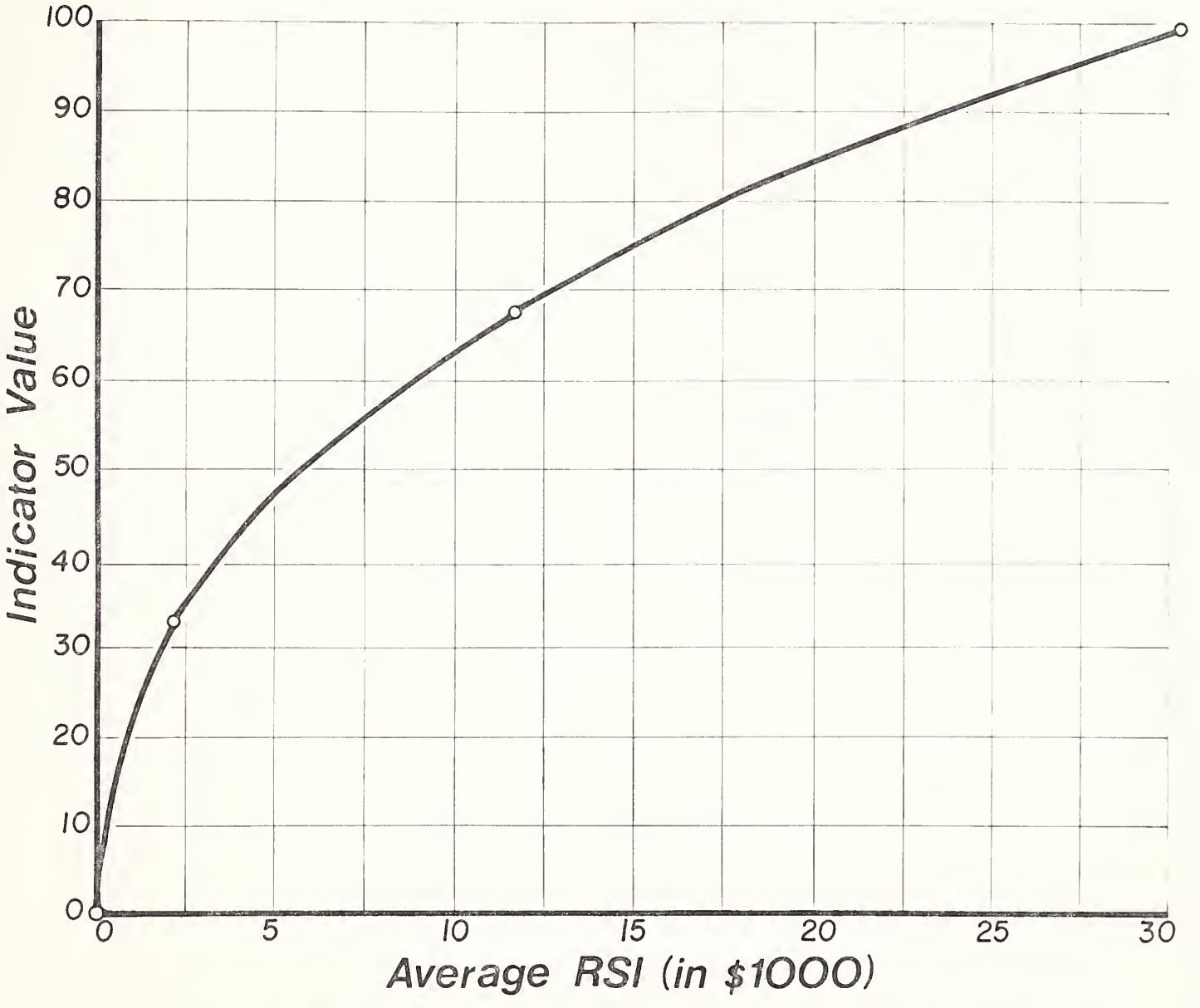
INDICATOR VALUES FOR NUMBER OF ACCIDENTS

FIGURE A3



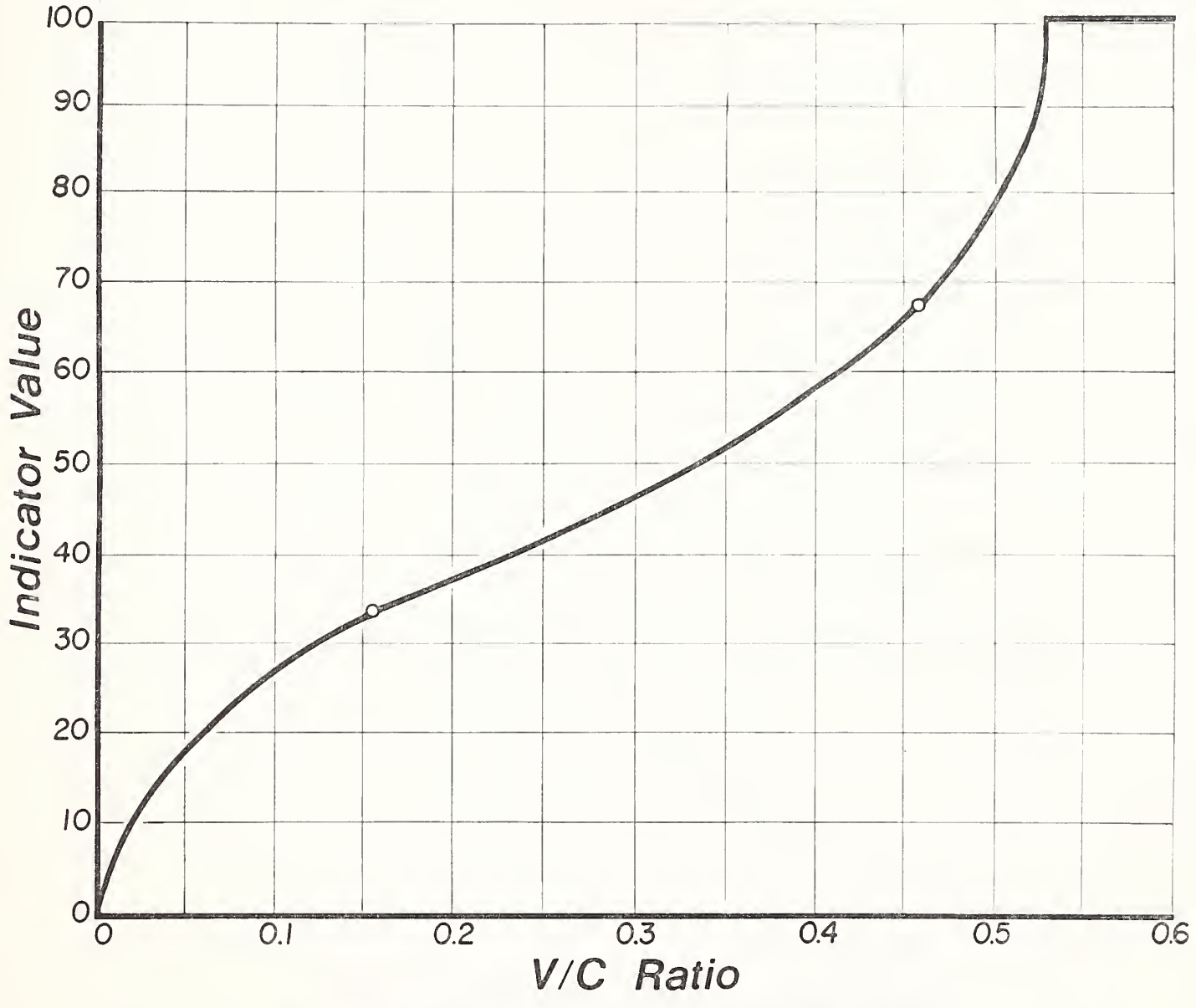
INDICATOR VALUES FOR ACCIDENT RATE

FIGURE A4



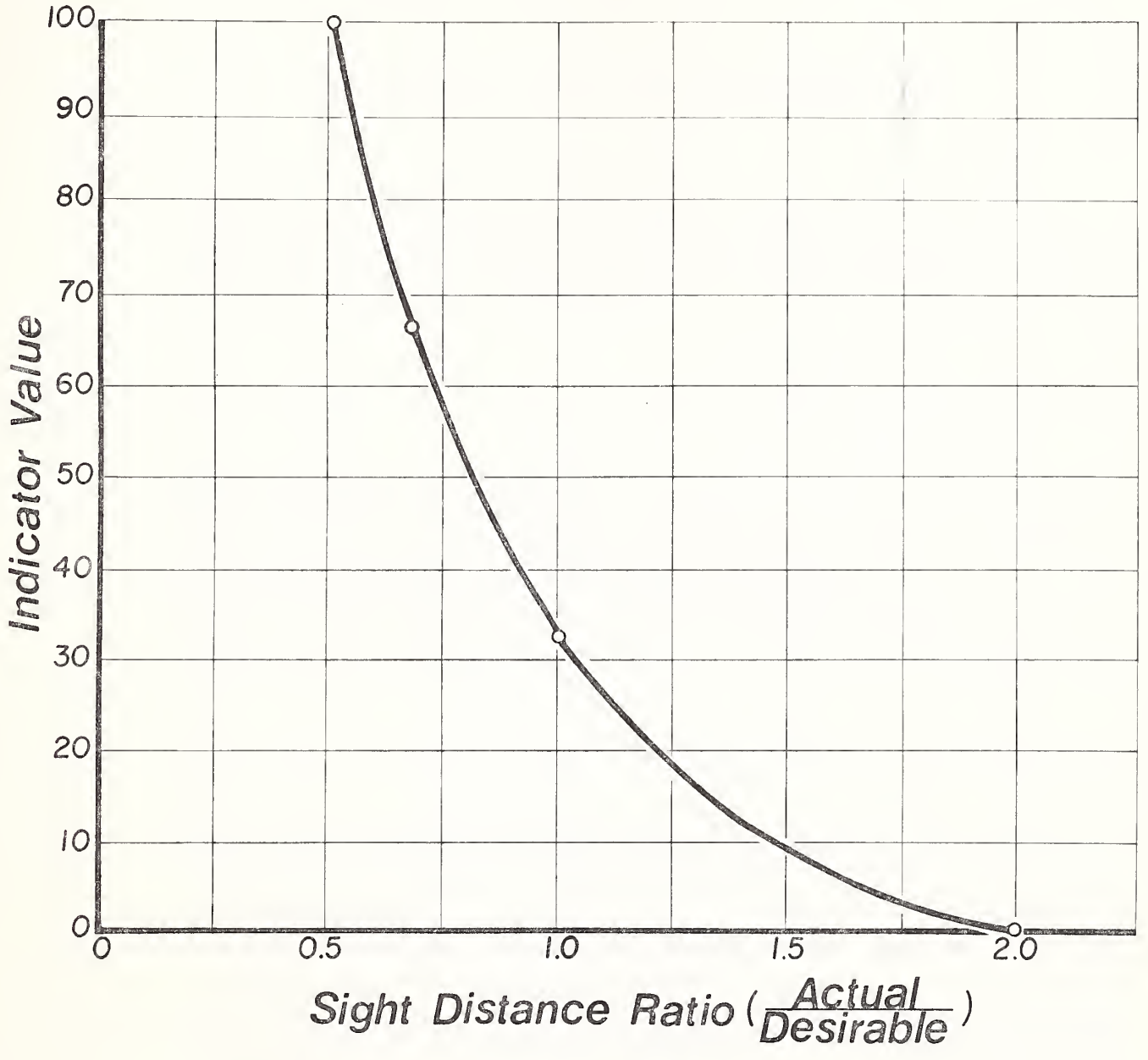
INDICATOR VALUE FOR ACCIDENT SEVERITY

FIGURE A5



INDICATOR VALUES FOR
V/C RATIO

FIGURE A6



INDICATOR VALUES FOR SIGHT DISTANCE

FIGURE A7

DRIVER EXPECTANCY PROBLEMS RATING FORM

Ratings

0 Nothing unexpected or unusual at this location.
Actions required (if any) entirely consistent with driving strategy on approach.
Standard geometry, with pathway(s) for intended movement(s) clearly evident.
No intereferences by other traffic likely.

1

2

3 Situation somewhat unexpected.
Driver must be alert, but should be able to respond adequately at "last minute" to most combinations of adverse circumstances.
Some initial confusion on intended path(s) or movement(s).
Interference from other traffic may create some degree of confusion or uncertainty for average driver.

4

5

6 Very unusual situation; will surprise many unfamiliar drivers.
Driver required to make major changes in driving tactics from those employed over past few miles.
At least a "near accident" almost expected if driver is even moderately inattentive; evasive actions likely to be required.
Intended pathway(s) confusing under fairly normal traffic or lighting conditions.
Other traffic, or lack of it, aggravates situation and misleads driver or deprives him of important cues.

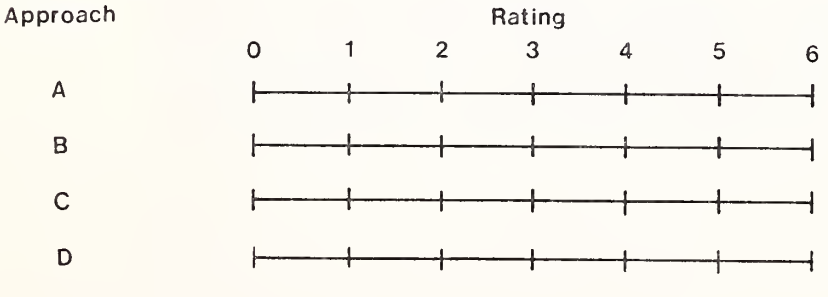
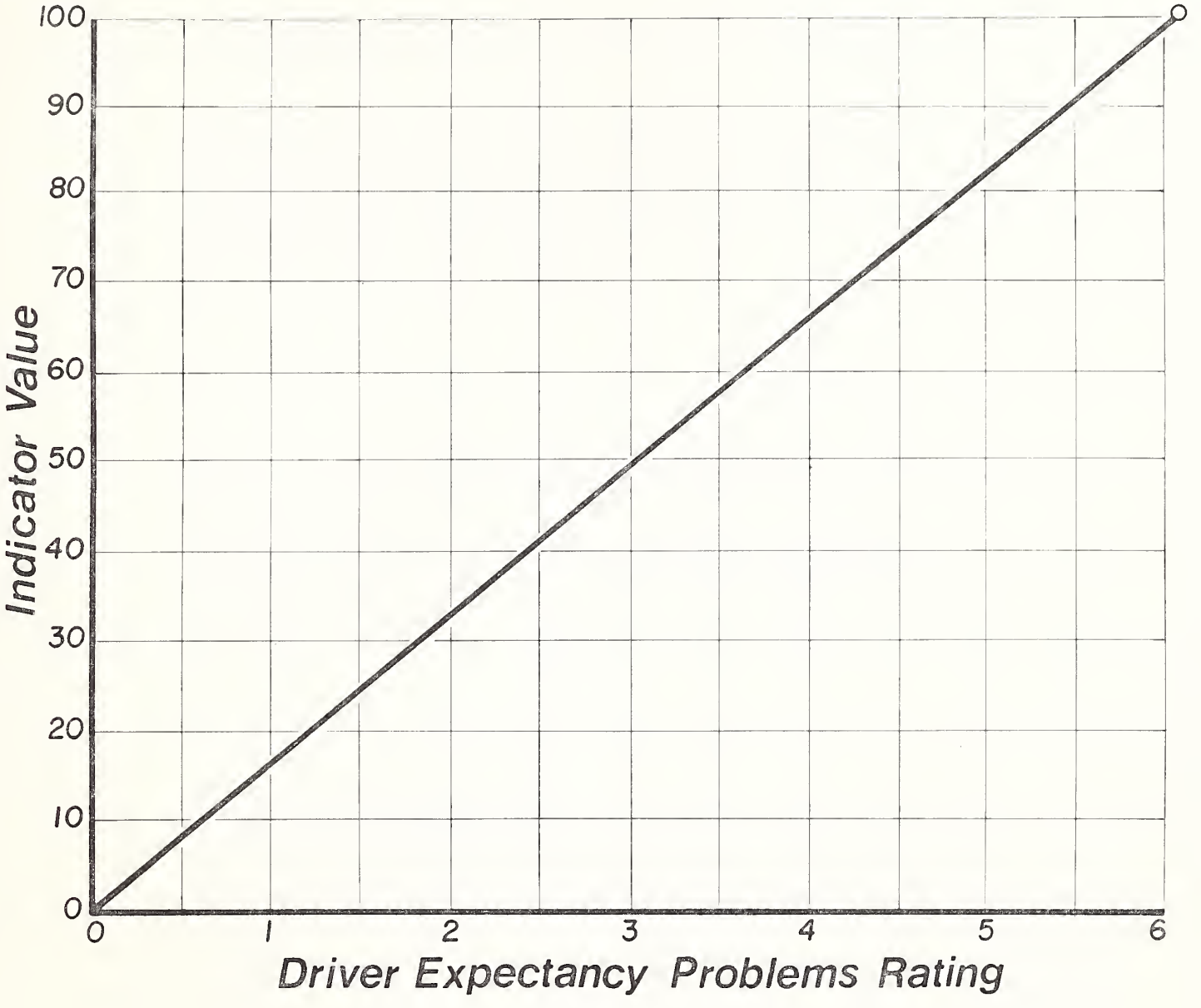


FIGURE A8



INDICATOR VALUES FOR DRIVER EXPECTANCY

FIGURE A9

INFORMATION SYSTEM DEFICIENCIES RATING FORM

Ratings

0 Information for required decisions complete and unambiguous.
Signs, markings, delineation in good repair, clean, highly visible.
"Positive guidance" leads driver to appropriate path; makes "error" difficult.
Approach speeds of most drivers are appropriate.
Light decision load; easy and obvious.

1

2

3 Some information lacking or somewhat misleading.
Signs should be moved or augmented for better visibility or to provide more decision time.
Visibility of signs, marking, and delineation barely adequate.
Medium decision load; average driver will be able to handle situation, but may be a little uncomfortable.

4

5

6 Important information missing.
Complete new "information system" needed — design and installation.
Present signs and markings in very poor condition; need replacement.
Speed limit and/or advisory speed needed; either missing or totally inappropriate at present.
"Positive guidance" on appropriate path lacking; a clutter of negative delineation only.
Heavy decision load; complete attention of average driver required; a "tense" situation at best.

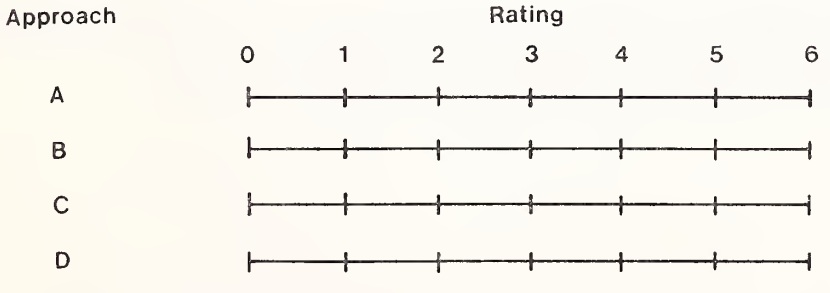
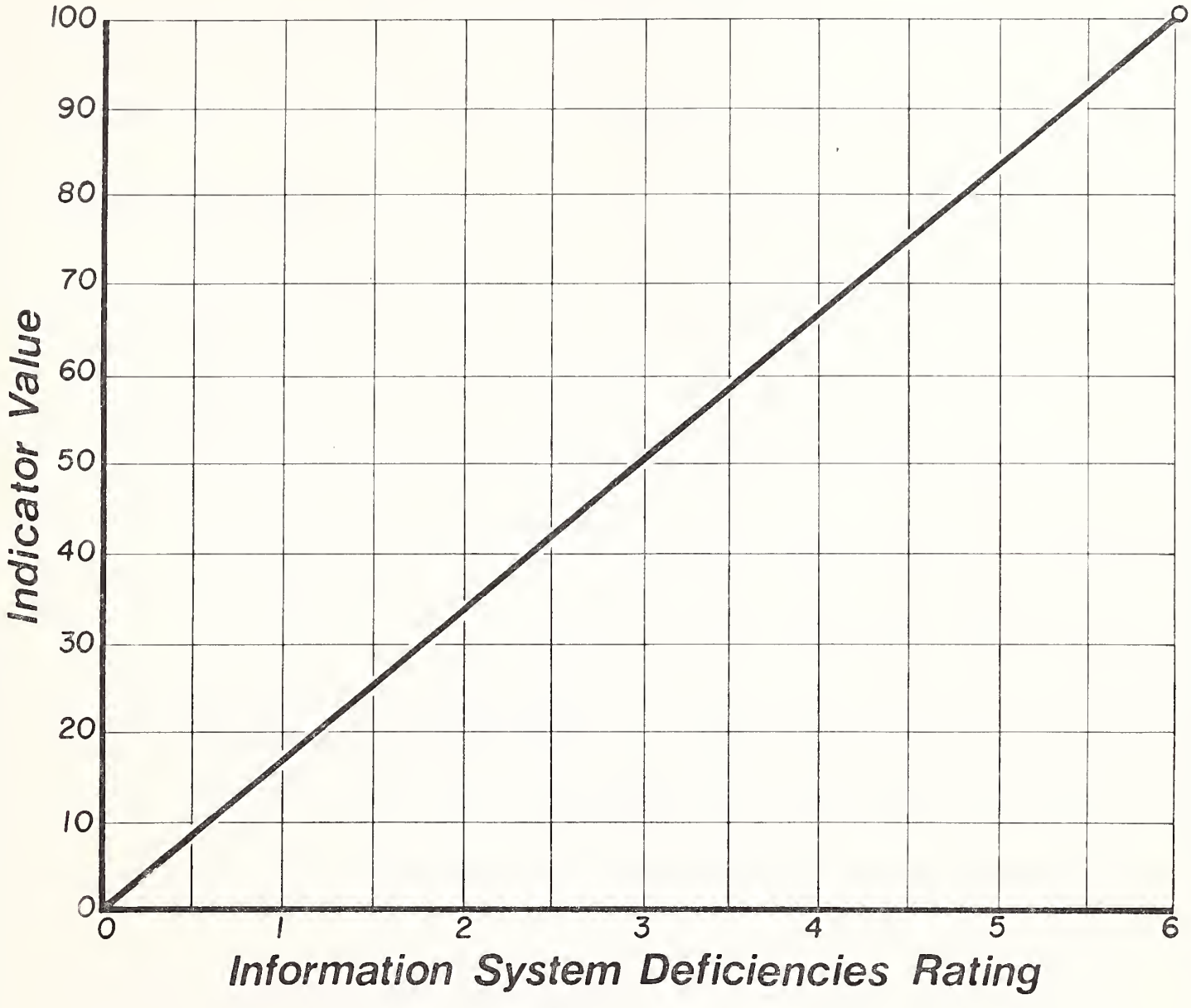


FIGURE AIO



INDICATOR VALUES FOR INFORMATION SYSTEM DEFICIENCIES

FIGURE A11

BENEFIT / COST RATIO WORKSHEET

Location: _____ Milepost: _____

Improvement Description: _____

_____

Estimated Service Life _____ Years = T

Compounded Interest Rate _____ % = R

Current 19___ ADT _____

Time Frame for Accident Data: From _____ To _____ = _____ Years

I. ANNUAL COST FOR THE IMPROVEMENT:

1. C = Capital Cost for Improvement $ _____
2. K = Capital Recovery Factor = $K = \frac{R(1+R)^T}{(1+R)^T - 1}$ = _____
3. M = Change in Annual Maintenance or Operation Cost $ _____
4. Annual Cost = (C K) + M = $ _____

II. ANNUAL BENEFIT OF THE IMPROVEMENT:

1. ADT_a = Average Daily Traffic After Improvement: _____
2. ADT_b = Average Daily Traffic Before Improvement: _____
3. I/F = Ratio of Injuries to Fatalities for the Class of Highway Involved: _____
4. $\frac{Q = * + (I/F)^{**}}{1 + I/F}$ = _____ = _____ = _____

   * Current cost of a fatal accident from National Safety Council memo No. 113 = $ _____

   ** Cost of an injury accident = $_____

5. Afi = Annual average number of fatal accidents and injury accidents combined at the location which will be affected by the improvement =

   $\frac{No.}{Years}$ = _____ = _____

FIGURE A12

6. Apd = Annual Average Number of Property Damage Accidents at the Location =

$$\frac{\text{No.}}{\text{Years}} = \underline{\qquad\qquad} = \underline{\qquad\qquad}$$

7. Pfi = Expected Percentage Reduction of Fatal and Injury Accidents by Improvement =

_____ %

8. Ppd = Expected Percentage Reduction of Property Damage Accidents by Improvement =

_____ %

a. P_1 = Largest percentage reduction in accident of any one of the improvements.

b. P_2 = Second largest percentage reduction in accidents of any of the improvements.

c. P_3 = Third largest percentage reduction in accidents of any of the improvements.

d. Pfi and Ppd for location where more than one improvement will be used in combination = $P_1 + \left(\frac{100 - P_1}{100}\right) P_2 + \left(\frac{100 - P_1}{100}\right)\left(\frac{100 - P_2}{100}\right) P_3 + \ldots$

9. Annual Benefit = $\frac{ADT_a}{ADT_b}$ [Q (Afi) pfi + *** (Apd) Ppd] = _____

*** Cost of a property damage accident = $_____

III. BENEFIT / COST RATIO = $\frac{\text{Annual Benefit}}{\text{Annual Cost}}$ = _____ = _____

FIGURE A12 (Continued)

RELATIVE SEVERITY INDEX

BY TYPE OF ACCIDENT *

Multi-Vehicle, At Intersection	Urban	Rural
Entering at angle	$4,300	$14,400
From same direction – both going straight	2,800	5,100
From same direction – one turn, one straight	2,500	5,100
From same direction – one stopped	3,800	5,200
From same direction – all others	2,000	6,300
From opposite direction – both going straight	4,000	20,000
From opposite direction – one left turn, one straight	4,400	15,400
From opposite direction – all others	2,700	3,800
Not stated	3,800	5,200
Multi-Vehicle, Non-Intersection		
Going opposite direction – both moving	$4,400	$19,600
Going same direction – both moving	2,900	8,100
One car parked	1,600	2,400
One car stopped in traffic	4,200	6,800
One car entering parked position	1,900	2,300
One car leaving parked position	1,200	2,700
One car entering alley or driveway	3,400	6,000
One car leaving alley or driveway	2,000	4,400
All others	1,700	7,600
Not stated	3,400	6,000
Motor Vehicle with Pedestrian, At Intersection and Non-Intersection		
Vehicle going straight	$20,000	$49,000
Vehicle turning right	13,600	11,200
Vehicle turning left	17,100	11,200
Vehicle backing	20,600	11,200
All others	14,500	11,200
Not stated	11,200	11,200

* FHWA-RD-77-87 "Identification of Hazardous Locations"

TABLE A1

Single Vehicle, at Intersection	Urban	Rural
Collision with train	$26,700	$39,100
Collision with bicycle	13,100	31,900
Injury in vehicle, jacknifed	5,200	2,000
Collision with fixed object in road	5,500	7,000
Overturned in road	9,200	7,500
Left road	5,200	12,300
Single Vehicle, Non-Intersection		
Collision with train	$26,700	$39,100
Collision with bicycle	13,100	31,900
Injury in vehicle, jacknifed	5,200	2,000
Collision with fixed object in road	6,300	9,200
Overturned in road	10,000	9,400
Left road at curve	7,600	12,400
Left road on straight road	5,200	10,500
Other One Motor Vehicle, At Intersection and Non-Intersection		
Fell from moving vehicle	$15,000	$57,200
Collision with animal	4,800	1,800
Collision with other object	4,700	4,400
All others	5,200	2,000
Not stated	3,200	3,400

TABLE A1 (Continued)